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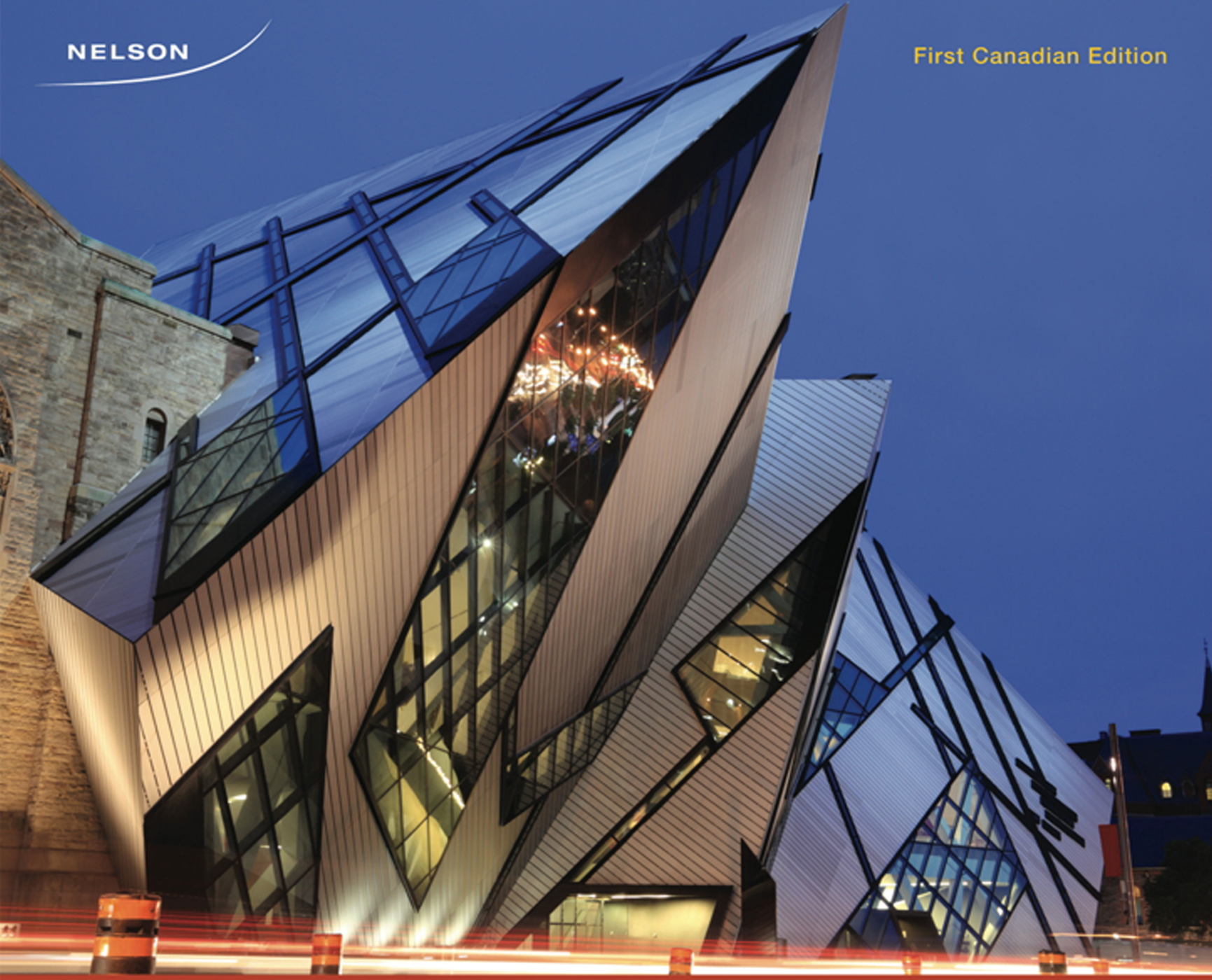

CORNERSTONES of Cost Accounting

HANSON • MOWEN • GEKAS • McCONOMY

Cornerstones OF Cost Accounting

First Canadian Edition

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NELSON EDUCATION

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by Don R. Hansen, Maryanne M. Mowen, George A. Gekas, and David J. McConomy

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Dedications

To my wife, Jan, and my four children, Kenn, Neil, Ryan, and Makenzie.

—Don Hansen

To my husband, John, and our children, Katherine and Cara.

—Maryanne Mowen

To my parents for their disciplined upbringing, and to my sons for their protective love.

—George Gekas

This book is dedicated to my wife, Candace, without whose support and encouragement I would never have succeeded.

—David McConomy

Brief Contents

Contents

CORNERSTONES— THE FOUNDATION FOR SUCCESSFUL LEARNING

Carefully crafted from the ground up, the "Cornerstones" in this text will help you set up and solve fundamental calculations or procedures. And the Cornerstones go beyond simple preparation by focusing on the underlying accounting principle. There is a Cornerstone for every major concept in the book, serving as a "How To" guide for when students are struggling to complete homework assignments. By being able to master the foundations of cost accounting, it will be easier for students to understand how accounting is used for decision making in the business world, making them more marketable to future employers!

Each Cornerstone has five parts: **Information**, **Why, Required, What If,** and **Solution.** Through this learning system, students understand both the calculations and the conceptual meaning behind them.

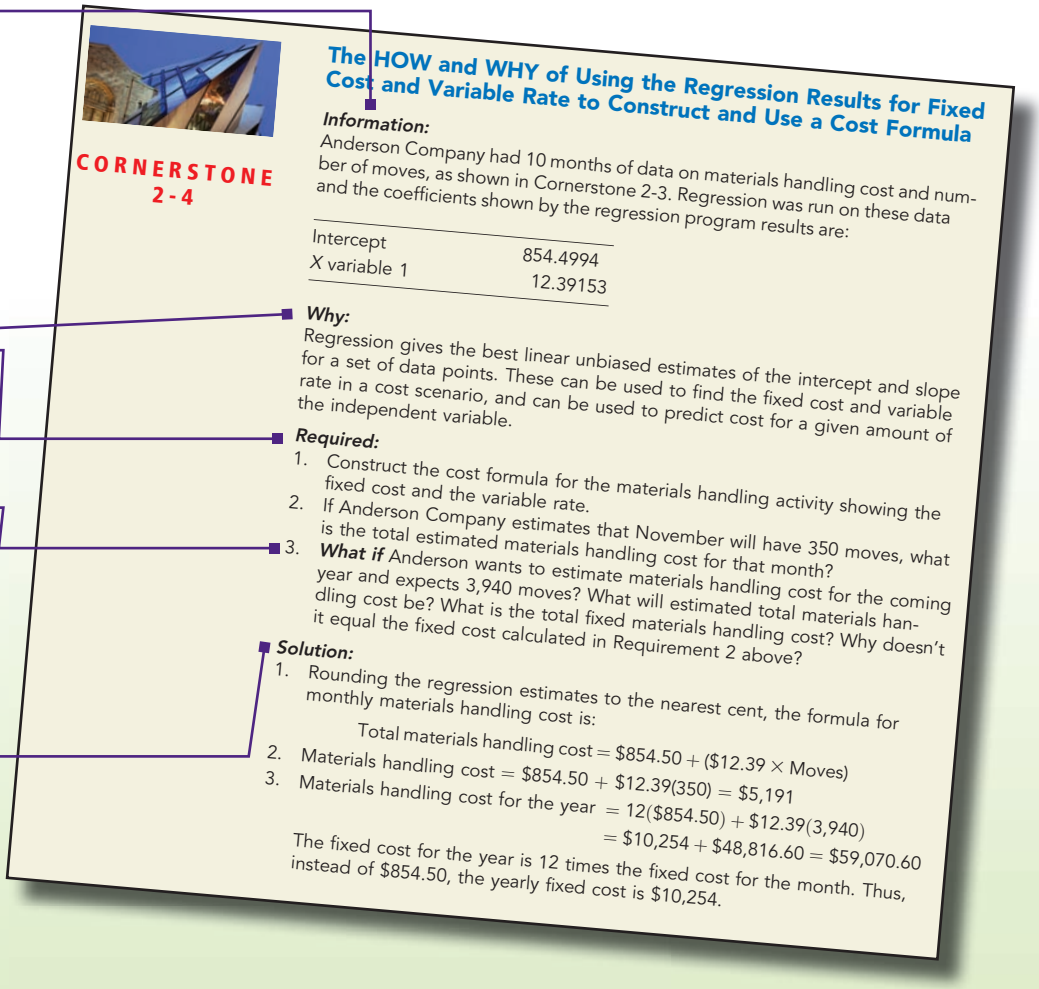
The ***Information*** portion of each Cornerstone provides the necessary data to arrive at a solution.

The ***Why*** section explains the reason each exercise is important and how it fits into the big picture of cost accounting.

The ***Required*** section of each example provides students with each step that must be solved.

The ***What If*** aspect of the example asks them to consider the implications if a variable were to change. This helps them to grasp the true conceptual meaning behind the calculation.

The ***Solution*** ends each Cornerstone, showing the calculations for each of the required steps in the problem. This helps students understand the necessary concepts.



CORNERSTONE 2-4

The HOW and WHY of Using the Regression Results for Fixed Cost and Variable Rate to Construct and Use a Cost Formula

Information:

Anderson Company had 10 months of data on materials handling cost and number of moves, as shown in Cornerstone 2-3. Regression was run on these data and the coefficients shown by the regression program results are:

Intercept	854.4994
X variable 1	12.39153

Why:

Regression gives the best linear unbiased estimates of the intercept and slope for a set of data points. These can be used to find the fixed cost and variable rate in a cost scenario, and can be used to predict cost for a given amount of the independent variable.

Required:

1. Construct the cost formula for the materials handling activity showing the fixed cost and the variable rate.
2. If Anderson Company estimates that November will have 350 moves, what is the total estimated materials handling cost for that month?
3. ***What if*** Anderson wants to estimate materials handling cost for the coming year and expects 3,940 moves? What will estimated total materials handling cost be? What is the total fixed materials handling cost? Why doesn't it equal the fixed cost calculated in Requirement 2 above?

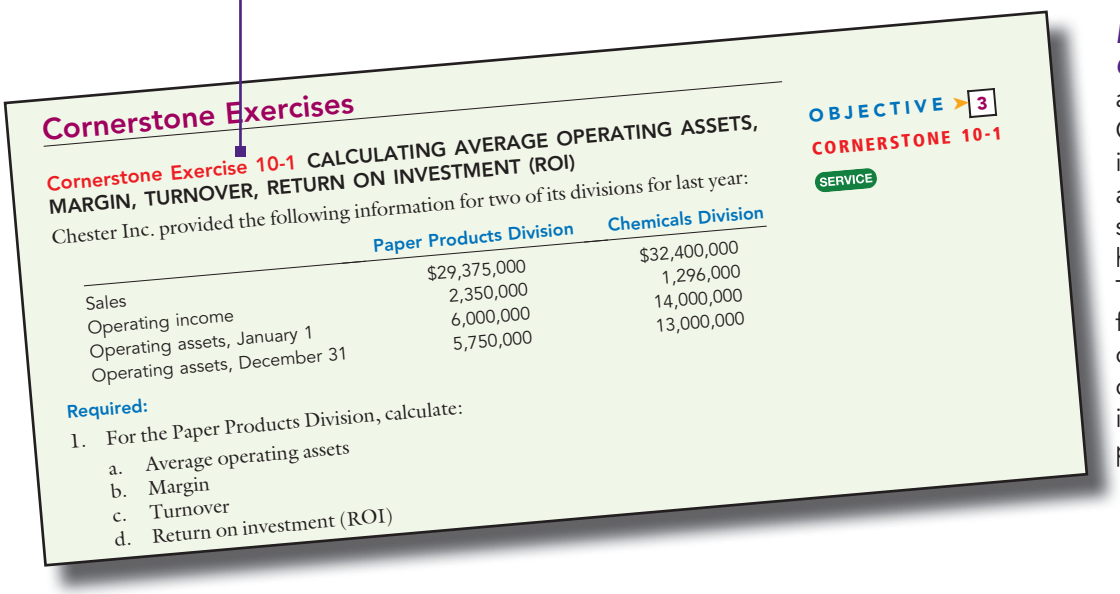
Solution:

1. Rounding the regression estimates to the nearest cent, the formula for monthly materials handling cost is:

   Total materials handling cost = $854.50 + ($12.39 × Moves)

2. Materials handling cost = $854.50 + $12.39(350) = $5,191
3. Materials handling cost for the year = 12($854.50) + $12.39(3,940)
   = $10,254 + $48,816.60 = $59,070.60

   The fixed cost for the year is 12 times the fixed cost for the month. Thus, instead of $854.50, the yearly fixed cost is $10,254.



Cornerstone Exercises

Cornerstone Exercise 10-1 CALCULATING AVERAGE OPERATING ASSETS, MARGIN, TURNOVER, RETURN ON INVESTMENT (ROI)

OBJECTIVE 3
CORNERSTONE 10-1
SERVICE

Chester Inc. provided the following information for two of its divisions for last year:

	Paper Products Division	Chemicals Division
Sales	$29,375,000	$32,400,000
Operating income	2,350,000	1,296,000
Operating assets, January 1	6,000,000	14,000,000
Operating assets, December 31	5,750,000	13,000,000

Required:

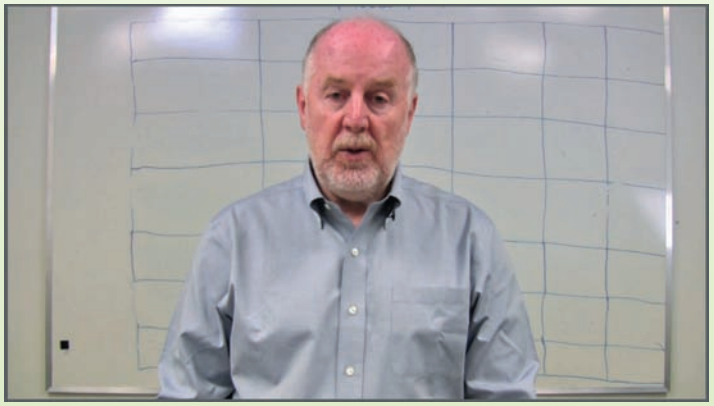
1. For the Paper Products Division, calculate:
   a. Average operating assets
   b. Margin
   c. Turnover
   d. Return on investment (ROI)

End-of-Chapter Cornerstone Exercises are linked to specific Cornerstone examples in the text, providing a valuable reference as students try to complete homework on their own. This provides a model for students as they go on to complete more complex problems, helping them become independent learners!

The primary driver of success in accounting is homework. Students believe a textbook helps them succeed, but they are using books differently than in previous generations. Students use books as a source of examples and descriptions to help them complete homework. They may skim the text before or after class, but very few read the text from beginning to end. As a result of this research, *Cornerstones* was fine-tuned to provide greater efficiency and more relevance, promising better results. *Cornerstones* provides students with the confidence to be more independent, allowing them more time to learn additional concepts.

The ***Cornerstones Learning System*** is based on how students learn accounting today. This system incorporates the following key features:

- The actual Cornerstones within the chapters—unique to this family of texts!
- The Cornerstones references within the end-of-chapter Cornerstones Exercises.
- The summary of Cornerstones at the end of each chapter, with page references.
- Online reinforcement of Cornerstones concepts with video podcasts at **http://www.hansen1ce.nelson.com**.



"I like the direct ability to transfer and hence reproduce the successful mastery of a concept … [which] reinforces the material. It is simple, straightforward, and identifiable to and by the student. It would work well in a distance course too."

—Elliott Currie, University of Guelph

Features of the First Canadian Edition

- The Canadian edition has been divided into four parts: Planning, Costing, Control, and Strategic Cost Management. Each part includes an opening page that details the concepts covered within and closes with a comprehensive problem that uses concepts from all chapters within the part.
- Chapters in the Canadian edition have been significantly reorganized in order to better reflect the sequence in which Canadian instructors teach and to group like topics in a logical order.
- For this edition, the number of chapters has been reduced from 20 to 18, with Chapter 18 appearing online only.
- Each chapter now includes CMA problems.
- The number of Cornerstones boxes has been reduced to avoid redundancy or unnecessary material.
- A number of Canadian examples have been included throughout the text. Companies and institutions include Canada Post, Bombardier, RIM, Magna, Toronto Maple Leafs, Air Canada, Porter Airlines, Petro Canada, and the Canadian Institute of Chartered Accountants.

INSTRUCTOR'S RESOURCES

NETA **The Nelson Education Teaching Advantage (NETA)** program is designed to deliver research-based resources that promote student engagement and higher-order thinking so as to enable the success of Canadian students and educators.

Testing Advantage Resources Nelson Education Ltd. understands that the highest quality multiple-choice Test Bank provides the means to measure ***higher-level thinking*** skills as well as recall. In response to instructor concerns, and recognizing the importance of multiple-choice testing in today's classroom, we have created the assessment component of the Nelson Education Teaching Advantage (NETA) program to ensure the value of our Test Banks.

The assessment component of our NETA program was created in partnership with David DiBattista, a 3M National Teaching Fellow, professor of psychology at Brock University, and researcher in the area of multiple-choice testing. All Test Bank authors have received training by Professor DiBattista in constructing effective multiple-choice questions and creating questions that assess higher-level thinking.

All NETA Test Banks are accompanied by David DiBattista's guide for instructors, *Multiple Choice Tests: Getting Beyond Remembering.* This guide has been designed to help you use Nelson Test Banks to achieve the desired outcomes in your course. Select the "NETA Assessment" button on the Instructor's Resource CD for a digital copy of this valuable resource, as well as the *Cornerstones of Cost Accounting* Test Bank and computerized Test Bank (see "Instructor's Resource CD" below for more information).

Instructor's Resource CD Key instructor ancillaries are provided on the Instructor's Resource CD (ISBN 0-17-663345-6), offering instructors the ultimate tool for customizing lectures and presentations. The IRCD includes the following:

- *Instructor's Manual.* The Instructor's Manual for *Cornerstones of Cost Accounting*, prepared by first Canadian edition co-author George Gekas, includes learning objectives; lesson summaries and teaching strategies; information about exercises, problems, and cases; and more.
- *NETA Test Bank and ExamView® Computerized Test Bank.* Test Bank files include multiple-choice questions and problems and are provided in rich text format for easy editing and printing with all common word-processing formats. All Test Bank questions are also provided in the ExamView® computerized version. This easy-to-use software is compatible with Microsoft Windows and Mac. Create tests by selecting questions from the question bank, modifying these questions as desired, and adding new questions you write yourself. You can administer quizzes online and export tests to WebCT, Blackboard, and other formats. A copy of *Multiple Choice Tests: Getting Beyond Remembering* accompanies the testing materials for *Cornerstones of Cost Accounting.*
- *Microsoft® PowerPoint®.* Key concepts from *Cornerstones of Cost Accounting* are presented in PowerPoint format, with generous use of figures, photographs, and short tables from the text. The PowerPoint slides for the First Canadian Edition were prepared by George Gekas.
- *Solutions Manual.* This manual, prepared by the authors of the text, has been independently checked for accuracy by Ross Meacher, C.A. It contains complete solutions to each discussion question, Cornerstone exercise, problem, and CMA problem in the text. Also included are solutions to the part-ending Integrative Exercises. The Cyber Research Cases and Collaborative Learning Exercises can be found on the companion website at **http://www.hansen1ce.nelson.com**.

- *Spreadsheet Solutions.* The complete solutions to the Excel-based Spreadsheet Exercises are provided.

STUDENT RESOURCES

Companion Website Visit **http://www.hansen1ce.nelson.com** for additional resources, including spreadsheet templates, self-testing review quizzes, glossary terms, flashcards, and the *Cornerstones* video podcasts.

ACKNOWLEDGMENTS AND THANKS

We have received assistance from many people who have contributed to this book. We are grateful for the assistance and support provided by Ryerson University and the Queen's University School of Business. Our appreciation is also extended to the Canadian Institute of Chartered Accountants (CICA), the Institute of Chartered Accountants of Ontario (ICAO), the Certified Management Accountants of Ontario (CMA Ontario), and to the other sources as indicated for their generous permission to use or adapt problems from their publications.

We would like to thank the following reviewers who helped shape the first edition:

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Finally, special recognition is due to our families for understanding the demands of our work and supporting our efforts.

George Gekas
David J. McConomy
March 2012

About the **Authors**

George A. Gekas is an Associate Professor of Management Accounting at the Ted Rogers School of Business Management at Ryerson University in Toronto. Prior to his appointment to Ryerson, he taught for more than 25 years at several universities in Canada, the United States, and Europe. His academic career includes appointments with the University College of Cape Breton, Algoma University College, Ryerson University, the University of Maryland, the American College of Greece (Deree), and the University of Western Ontario.

Dr. Gekas received his first honours B.A. degree from the Athens University of Economics in Greece. He then earned a Master of Economics from Lakehead University, honours Bachelor of Commerce and MBA degrees from the University of Windsor, and a Ph.D. from Hull University in England. In addition, he is a Certified Management Accountant (CMA), awarded the prestigious FCMA designation, and is actively involved in the Society of Management Accountants of Ontario, for which he has held a number of positions. Currently he is Chair of its Complaints Committee. Recently, he was appointed CMA in residence at the Ted Rogers School of Business Management, the first such appointment in Canada.

Dr. Gekas has published a number of articles on a wide variety of business topics, as well as teaching aids and manuals. His expertise covers the financial management spectrum, with a focus on strategic management, operational efficiency, accountability, and corporate performance.

As a university educator and educational administrator, Dr. Gekas has been involved in a variety of capacities in a number of post-secondary educational projects and is fully immersed in the issues facing Canadian post-secondary institutions and universities. He also has a strong interest in community and social development.

David J. McConomy is an Assistant Professor at the Queen's University School of Business. He graduated with an MBA from Queen's University with a major in Finance and Accounting in 1969 after receiving a BA (Econ) from Loyola College (now part of Concordia University) in Montreal. Since qualifying as a chartered accountant with Arthur Andersen & Co. in Toronto, his 30-year career in business has focused on the finance and accounting requirements of small to medium-sized companies.

He has gained considerable experience assisting young companies, mainly in the technology field, in strategic planning and corporate finance. As Chief Financial Officer of Systemhouse Ltd. (which was later sold to MCI and subsequently to EDS), he was instrumental in taking that company public. During his tenure with Systemhouse, revenues rose from $16.5 million to in excess of $100 million.

With Antares Electronics Inc., he raised $20 million (through venture capital investments, sale-and-leaseback transactions, and the restructuring of bank lines of credit) to enable the company to become one of *Profit* magazine's fastest growing companies, as revenues increased over a three-year period from $36 million to

$100 million. Later, he helped ComnetiX Computer Systems Inc. to become a public company and to raise funds from a variety of sources to fund its growth.

Since joining the faculty of the Queen's School of Business in 2001, he has won numerous Faculty Teaching Awards. He prides himself in engaging with students both within the classroom and outside of it.

Mr. McConomy has taught accounting, financial management, and business strategy (at the undergraduate and MBA levels) on both a full-time and part-time basis at Queen's University, the University of Ottawa, and internationally with the Academy of Economic Studies in Bucharest, Romania, and in Beijing, China.

Don R. Hansen is the Head of the School of Accounting and Kerr McGee Chair at Oklahoma State University. He received his Ph.D. from the University of Arizona in 1977. He has an undergraduate degree in mathematics from Brigham Young University. His research interests include activity-based costing and mathematical modelling. He has published articles in both accounting and engineering journals including *The Accounting Review, The Journal of Management Accounting Research, Accounting Horizons,* and *Accounting Organizations and Society.* He has served on the editorial board of *The Accounting Review.* His outside interests include family, church activities, reading, movies, watching sports, and studying Spanish.

Maryanne M. Mowen is Associate Professor of Accounting at Oklahoma State University. She received her Ph.D. from Arizona State University. She brings an interdisciplinary perspective to teaching and writing in cost and management accounting, with degrees in history and economics. She also teaches classes in ethics and the impact of the Sarbanes-Oxley Act on accountants. Her scholarly research is in the areas of management accounting, behavioural decision theory, and compliance with the Sarbanes-Oxley Act. She has published articles in journals such as *Decision Science, The Journal of Economics and Psychology,* and *The Journal of Management Accounting Research.* Dr. Mowen has served as a consultant to mid-sized and Fortune 100 companies and works with corporate controllers on management accounting issues. Outside the classroom, she enjoys hiking, travelling, reading mysteries, and crossword puzzles.

Part 1 PLANNING

In any organization, the management process consists of several very important steps including planning, implementing, evaluating, and taking corrective action. Managers are expected to take a forward-looking approach to running the organization and to planning the manner in which actions will be taken to make the organization a success.

The first part of this textbook deals with the elements required in the planning phase. By understanding the basic cost management concepts, we will be able to determine how the actions that managers take will influence the outcomes. By focusing on costs, managers can have a significant impact on the end result.

Fundamental to being able to predict what the outcomes of certain actions will be is the requirement to understand how costs behave. By understanding cost behaviour, a manager can predict what changes will result if one course of action is pursued rather than another.

In most organizations, the object of the exercise is to generate a profit. Companies that have the luxury of pursuing actions that will benefit the greater good are those that are producing a profit. Therefore, understanding the relationship between the activities of an organization and the profits that it can generate will form a significant part of the decision-making process. The cost-volume-profit relationships will help managers understand the probable impact of their actions.

After studying this chapter, you should be able to:

1. Describe a cost management information system, its objectives, and its major subsystems, and indicate how it relates to other operating and information systems.
2. Explain the cost assignment process.
3. Define tangible and intangible products, and explain why there are different product cost definitions.
4. Prepare income statements for manufacturing and service organizations.
5. Understand the importance of ethical behaviour for management accountants.

CHAPTER

1 Basic Cost Management Concepts

Financial Accounting versus Cost Management Accounting: A Systems Framework

A systems framework helps us understand the variety of topics that appear in the field of **cost management**. It also facilitates our ability to understand the differences between financial accounting and cost management. An **accounting information system** consists of interrelated manual and computer parts and uses processes such as collecting, recording, summarizing, analyzing, and managing data to transform inputs into information that is provided to users.

The accounting information system within an organization has two major subsystems: (1) *the financial accounting information system* and (2) *the cost management accounting information system*. One of the major differences between the two systems is the targeted user.

A Systems Framework

OBJECTIVE 1

Describe a cost management information system, its objectives, and its major subsystems, and indicate how it relates to other operating and information systems.

A **system** is a set of interrelated parts that performs one or more processes to accomplish specific objectives. Consider a home theatre system. This system has a number of interrelated parts such as the speakers, the receiver, the amplifier, the television, and the DVD player. The most obvious process (or series of actions designed to accomplish an objective) is the playing of a movie; another is the delivery of surround sound throughout the room. The primary objective of the system is to provide a theatre-quality experience while watching a movie. Notice that each part of the system is critical to achieve the overall objective. For example, if the speakers were missing, the amplifier and receiver would not be able to provide theatre-quality sound even if the other parts were present and functional.

A system works by using processes to transform inputs into outputs that satisfy the system's objectives. Consider the movie-playing process. This process requires inputs such as a movie (typically on Blu-ray or DVD), a Blu-ray or DVD player, a television set, and electricity. The inputs are transformed into the replay of the movie, an output of this process. The output of the process, delivery of surround sound, is obviously critical to achieving the overall objective of the system. The encoded sounds on the DVD become the inputs to the delivery process. This process transforms the inputs so that tracks of sound are delivered to each of the speakers throughout the room.

Accounting Information Systems

An information system is designed to provide information to people in the company who might need it. For example, the human resource (HR) information system and the materials requirements planning (MRP) system are both information systems. The HR system tracks people as they are hired. It includes data on date of hire, entry-level title and salary/wages, and any information needed for determining employee benefits. The MRP is a computerized system that keeps track of the purchase and use of raw materials used in manufacturing.

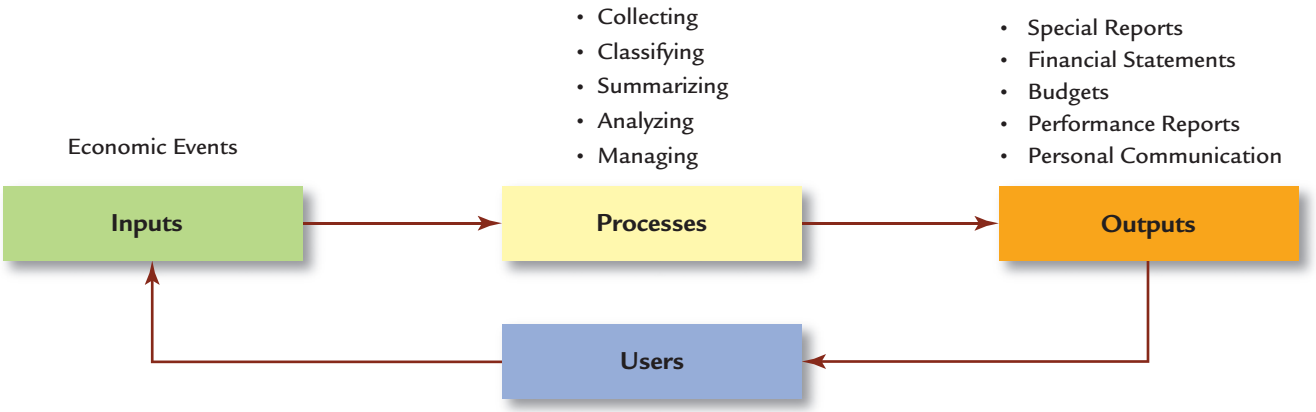
Like any system, an accounting information system has objectives, interrelated parts, processes, and outputs. The overall objective of an accounting information system is to provide information to users. The interrelated parts include order entry and sales, billing, accounts receivable and cash receipts, inventory, general ledger, and cost accounting. Each of these interrelated parts is itself a system and is therefore referred to as a *subsystem* of the accounting information system. Processes include activities such as collecting, classifying, summarizing, and managing data. Some processes may also be formal decision models—models that use inputs and provide recommended decisions as the information output. The outputs are data and reports that provide needed information for users.

Two key features of the accounting information system distinguish it from other information systems. First, an accounting information system's inputs are usually economic events. Second, the operational model of an accounting information system is critically involved with the user of information, since the output of the information system influences users and may serve as the basis for action. This is particularly true for tactical and strategic decisions but less true for day-to-day decisions. In other cases, the output may serve to confirm that the actions taken had the intended effects.[1] Another possible output is feedback, which becomes an input for subsequent

[1] This role of information is described in William J. Bruns, Jr., and Sharon M. McKinnon, "Information and Managers: A Field Study," *Journal of Management Accounting Research* 5 (Fall 1993): 86–108. The paper reports on a field study of how managers use accounting information. The authors point out that formal information output does not seem to be used for day-to-day decisions. Managers often use interpersonal relationships to acquire information for daily use. Support for this view can be found in David Marginson, "Information Processing and Management Control: A Note Exploring the Role Played by Information Media in Reducing Role Ambiguity," *Management Accounting Research* 17 (June 2006): 187–197.

Exhibit 1-1

Operational Model of an Accounting Information System



operational system performance. The operational model for an accounting information system is illustrated in Exhibit 1-1. Examples of the inputs, processes, and outputs are provided in the exhibit. (The list is not intended to be exhaustive.) Notice that personal communication is an information output. Often, users may not wish to wait for formal reports and can obtain needed information on a timelier basis by communicating directly with accountants.

The accounting information system can be divided into two major subsystems: (1) the *financial accounting information system* and (2) the *cost management information system*. While we emphasize the second, it should be noted that the two systems need not be independent.[2] Ideally, the two systems should be integrated and have linked databases. Output of each of the two systems can be used as input for the other system.

The Financial Accounting Information System The **financial accounting information system** is primarily concerned with producing outputs for *external* users. It uses well-specified economic events (e.g., payment of wages, purchases of materials) as inputs, and its processes follow certain rules and conventions. For financial accounting, the nature of the inputs and the rules and conventions governing processes, generally accepted accounting principles (GAAP), are defined by the Canadian Institute of Chartered Accountants (CICA), the provincial securities commissions, and the International Accounting Standards Board (IASB). Among its outputs are financial statements such as the balance sheet, income statement, and statement of cash flows for external users (investors, creditors, government agencies, and other outside users). Financial accounting information is used for investment decisions, stewardship evaluation, activity monitoring, and regulatory measures.

The Cost Management Information System The **cost management information system** is primarily concerned with producing outputs for *internal* users using inputs and processes needed to satisfy management objectives. The cost management information system is not bound by externally imposed criteria that define inputs and processes. Instead, the criteria that govern the inputs and processes are set by people in the company. The cost management information system provides information for three broad objectives:

[2] Much of the material from this point on in this section relies on information found in the following articles: Robert S. Kaplan, "The Four-Stage Model of Cost Systems Design," *Management Accounting* (February 1990): 22–26; Steven C. Schnoebelen, "Integrating an Advanced Cost Management System into Operating Systems (Part 1)," *Journal of Cost Management* (Winter 1993): 50–54; and Steven C. Schnoebelen, "Integrating an Advanced Cost Management System into Operating Systems (Part 2)," *Journal of Cost Management* (Spring 1993): 60–67.

1. Costing services, products, and other objects of interest to management
2. Planning and control
3. Decision making

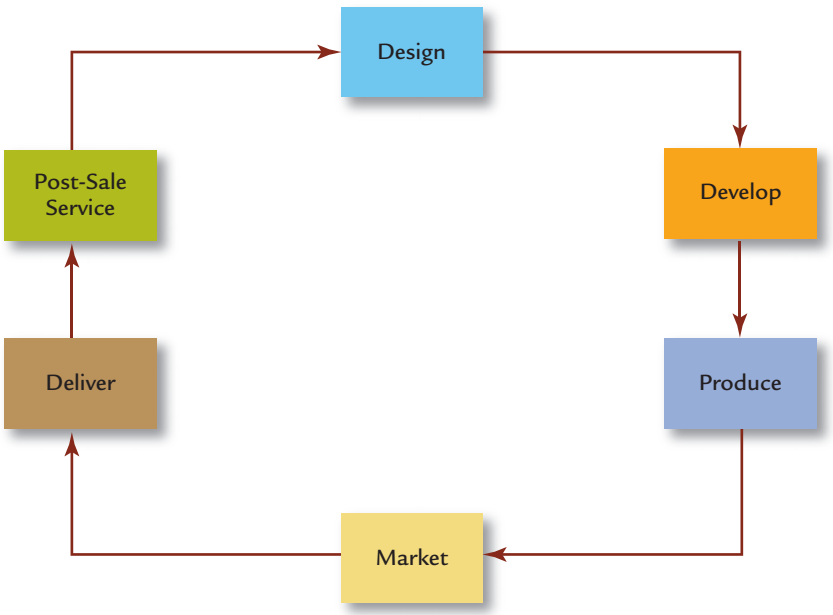
How much does a product or service cost? That depends on the reason why management wants to know the cost. For example, product costs calculated in accordance with GAAP are needed to value inventories for the balance sheet and to calculate the cost of goods sold expense on the income statement. These product costs include the cost of materials, labour, and overhead. In other cases, managers may want to know all costs that are associated with a service for purposes of tactical and strategic profitability analysis. For example, a bank might want to know the costs and revenues associated with providing small business loans. Then additional cost information may be needed concerning service provision, the cost of funds, collection costs, and so on.

Cost information is also needed for planning and control. It should help managers decide what should be done, why it should be done, how it should be done, and how well it is being done. For example, pharmaceutical companies may want to consider life cycle costing of individual drugs or drug families. The expected revenues and costs may cover the entire life of the new product. Thus, projected costs of research, development, testing, production, marketing, distribution, and servicing would be essential information. These costs form the basis of the value chain.

The **value chain** is the set of activities required to design, develop, produce, market, deliver, and provide post-sales service for the products and services sold to customers. Exhibit 1-2 illustrates the business processes of the value chain. Emphasizing customer value forces managers to determine which activities in the value chain are important to customers. The cost management information system should track information about the wide variety of activities that span the value chain. Consider, for example, the delivery segment. Timely delivery of a product or service is part of the total product and, thus, is of value to the customer. Customer value can be increased by increasing the speed of delivery and response. **Federal Express** exploited this part of the value chain and successfully developed a service that was not being offered by **Canada Post**. Today, many customers believe that delivery delayed is delivery denied. This indicates that a good cost management information system ought to develop and measure indicators of customer satisfaction.

Exhibit 1-2

The Value Chain



Companies have internal customers as well. For example, the procurement process acquires and delivers parts and materials to producing departments. Providing high-quality parts on a timely basis to managers of producing departments is just as vital for procurement as it is for the company as a whole to provide high-quality goods to external customers. The emphasis on managing the internal value chain and servicing internal customers has revealed the importance of a cross-functional perspective. Internal and external value chains will be discussed in more detail in Chapter 13.

Finally, cost information is important for many managerial decisions. For example, a manager may need to decide whether to continue making a component in-house or to buy it from an external supplier. In this case, the manager would need to know the cost of materials, labour, and other productive resources associated with the manufacture of the component and which of these costs would disappear if the product were no longer produced. Also needed is information about the cost of purchasing the component, including any increase in cost for internal activities such as receiving and storing goods.

Relationship of Cost Accounting to Other Operational Systems and Functions

The cost information produced by the cost management information system benefits the whole organization and should have an organization-wide perspective. Managers in many different areas of a business require cost information. For example, an engineering manager must make strategic decisions concerning product design. Later costs of production, marketing, and servicing can vary widely, depending on the design. An engineer at **Hewlett-Packard** once told us that 70 percent of eventual product costs are "locked in" during the design process. To provide accurate cost information for the different design options, the cost management system must interact not only with the design and development system but also with the production, marketing, and customer service systems. Cost information for tactical decision making is also important. For example, a sales manager needs reliable and accurate cost information when faced with a decision concerning an order that may be sold for less than the normal selling price. Such a sale may only be feasible if the production system has idle capacity. In this case, a sound decision requires interaction among the cost management system, the marketing and distribution system, and the production system. These two examples illustrate that the cost management system should have an organization-wide perspective and that it must be properly integrated with the nonfinancial functions and systems within an organization.

An integrated cost management system receives information from and provides information to all operational systems. To the extent possible, the cost management system should be integrated with the organization's operational systems. Integration reduces redundant storage and use of data, improves the timeliness of information, and increases the efficiency of producing reliable and accurate information. One way of accomplishing this is to implement an enterprise resource planning (ERP) system. ERP systems strive to input data once and make it available to people across the company for whatever purpose it may serve. For example, a sales order entered into an ERP system is used by marketing to update customer records, by production to schedule the manufacture of the goods ordered, and by accounting to record the sale.

Factors Affecting Cost Management

Worldwide competitive pressures, deregulation, growth in the service industry, and advances in information and manufacturing technology have changed the nature of our economy and caused many manufacturing and service industries to dramatically change the way in which they operate. These changes, in turn, have prompted the development of innovative and relevant cost management practices. For example, activity-based accounting systems have been developed and implemented in many organizations. Additionally, the focus of cost management accounting systems has

been broadened to enable managers to better serve the needs of customers and manage the firm's business processes that are used to create customer value. A firm can establish a competitive advantage by providing more customer value for less cost than its competitors. To secure and maintain a competitive advantage, managers seek to improve time-based performance, quality, and efficiency. Accounting information must be produced to support these three fundamental organizational goals.

Global Competition

Vastly improved transportation and communication systems have led to a global market for many manufacturing and service firms. Several decades ago, firms neither knew nor cared what similar firms in Japan, France, Germany, and Singapore were producing. These foreign firms were not competitors since their markets were separated by geographical distance. Now, both small and large firms are affected by the opportunities offered by global competition. **Stillwater Designs**, a small firm that designs and markets Kicker speakers, has significant markets in Europe. The manufacture of the Kicker speakers is mostly outsourced to Asian producers. At the other end of the size scale, **Bombardier**, **Research In Motion**, and **Magna International** are developing sizable markets in China. Automobiles manufactured in Japan can be in North America in two weeks. Investment bankers and management consultants can communicate with foreign offices instantly. Improved transportation and communication in conjunction with higher quality products that carry lower prices have upped the ante for all firms. This new competitive environment has increased the demand not only for more cost information but also for more accurate cost information. Cost information plays a vital role in reducing costs, improving productivity, and assessing product line profitability.

Growth of the Service Industry

As traditional industries have declined in importance, the service sector of the economy has increased in importance. The service sector now comprises approximately three quarters of many economies and their workers. Many services—among them accounting services, transportation, and medical services—are exported. Experts predict that this sector will continue to expand in size and importance as service productivity grows. Deregulation of many services (e.g., airlines and telecommunications in the past and utilities in the present) has increased competition in the service industry. Many service organizations are scrambling to survive. The increased competition has made managers in this industry more conscious of the need to have accurate cost information for planning, controlling, continuous improvement, and decision making. Thus, the changes in the service sector add to the demand for innovative and relevant cost management information.

Advances in Information Technology and the Manufacturing Environment

Three significant advances relate to information technology. One is intimately connected with computer-integrated applications. With automated manufacturing, computers are used to monitor and control operations. Because a computer is being used, a considerable amount of useful information can be collected, and managers can be informed about what is happening within an organization almost as it happens. It is now possible to track products continuously as they move through the factory and to report (on a real-time basis) such information as units produced, material used, scrap generated, and product cost. The outcome is an operational information system that fully integrates manufacturing with marketing and accounting data.

Manufacturing management approaches such as the theory of constraints and just-in-time have allowed firms to increase quality, reduce inventories, eliminate waste, and reduce costs. Automated manufacturing has produced similar outcomes.

The impact of improved manufacturing technology and practices on cost management is significant. Product costing systems, control systems, allocation, inventory management, cost structure, capital budgeting, variable costing, and many other accounting practices are being affected.

Theory of Constraints The **theory of constraints** is a method used to continuously improve manufacturing and nonmanufacturing activities. It is characterized as a "thinking process" that begins by recognizing that all resources are finite. Some resources, however, are more critical than others. The most critical limiting factor, called a constraint, becomes the focus of attention. By managing this constraint, performance can be improved. To manage the constraint, one must identify and exploit it (i.e., performance must be maximized subject to the constraint). All other actions are subordinate to the exploitation decision. Finally, to improve performance, the constraint must be elevated. The process is repeated until the constraint is eliminated (i.e., it is no longer the critical performance-limiting factor). The process then begins anew with the resource that has now become the critical limiting factor. Using this method, lead times and, thus, inventories can be reduced.

Just-in-Time Manufacturing A demand-pull system, **just-in-time (JIT) manufacturing** strives to produce a product only when it is needed and only in the quantities demanded by customers. Demand, measured by customer orders, pulls products through the manufacturing process. Each operation produces only what is necessary to satisfy the demand of the succeeding operation. No production takes place until a signal from a succeeding process indicates the need to produce. Parts and materials arrive just in time to be used in production.

JIT manufacturing typically reduces inventories to much lower levels (theoretically to insignificant levels) than those found in conventional systems, increases the emphasis on quality control, and produces fundamental changes in the way production is organized and carried out. Basically, JIT manufacturing focuses on continual improvement by reducing inventory costs and dealing with other economic problems. Reducing inventories frees up capital that can be used for more productive investments. Increasing quality enhances the competitive ability of the firm. Finally, changing from a traditional manufacturing setup to JIT manufacturing allows the firm to focus more on quality and productivity and, at the same time, allows a more accurate assessment of what it costs to produce products.

Computer-Integrated Manufacturing Automation of the manufacturing environment allows firms to reduce inventory, increase productive capacity, improve quality and service, decrease processing time, and increase output. Automation can produce a competitive advantage for a firm. The implementation of an automated manufacturing facility typically follows JIT and is a response to the increased needs for quality and shorter response times. As more firms automate, competitive pressures will force other firms to do likewise. For many manufacturing firms, automation may be equivalent to survival.

If automation is justified, it may mean installation of a computer-integrated manufacturing (CIM) system. CIM implies the following capabilities: (1) the products are designed through the use of a computer-assisted design (CAD) system; (2) a computer-assisted engineering (CAE) system is used to test the design; (3) the product is manufactured using a computer-assisted manufacturing (CAM) system (CAMs use computer-controlled machines and robots); and (4) an information system connects the various automated components.

A particular type of CAM is the flexible manufacturing system. Flexible manufacturing systems are capable of producing a family of products from start to finish using robots and other automated equipment under the control of a mainframe computer. This ability to produce a variety of products with the same set of equipment is clearly advantageous.

Cost Assignment: Direct Tracing, Driver Tracing, and Cost Allocation

OBJECTIVE 2
Explain the cost assignment process.

To study cost accounting and operational control systems, we need to understand the meaning of cost and to become familiar with the cost terminology associated with the two systems. We must also understand the process used to assign costs. Cost assignment is one of the key processes of the cost accounting system. Improving the cost assignment process has been one of the major developments in the cost management field in the past 20 to 30 years. First, let's define cost.

Cost is the cash or cash equivalent value sacrificed for goods and services that are expected to bring a current or future benefit to the organization. We say *cash equivalent* because noncash assets can be exchanged for the desired goods or services. For example, it may be possible to trade equipment for materials used in production.

Costs are incurred to produce future benefits. In a profit-making firm, future benefits usually mean revenues. As costs are used up in the production of revenues, they are said to expire. Expired costs are called **expenses**. In each period, expenses are deducted from revenues on the income statement to determine the period's profit. A **loss** is a cost that expires without producing any revenue benefit. For example, the cost of uninsured inventory destroyed by a flood would be classified as a loss on the income statement.

Many costs do not expire in a given period. These unexpired costs are classified as **assets** and appear on the balance sheet. Computers and factory buildings are examples of assets lasting more than one period. Note that the main difference between a cost being classified as an expense or as an asset is timing. This distinction is important and will be referred to in the development of other cost concepts later in the text.

Cost Objects

Cost accounting information systems are structured to measure and assign costs to cost objects. **Cost objects** can be anything for which costs are measured and assigned; they may include products, customers, departments, projects, activities, and so on. For example, if we want to determine what it costs to produce a bicycle, then the cost object is the bicycle. If we want to determine the cost of operating a maintenance department within a plant, then the cost object is the maintenance department. If we want to determine the cost of developing a new toy, then the cost object is the new toy development project. Activities are a special kind of cost object. An **activity** is a basic unit of work performed within an organization. An activity can also be defined as an aggregation of actions within an organization useful to managers for purposes of planning, controlling, and decision making. In recent years, activities have emerged as important cost objects. Activities play a prominent role in assigning costs to other cost objects and are essential elements of an activity-based cost accounting system. Examples of activities include setting up equipment for production, moving materials and goods, purchasing parts, billing customers, paying bills, maintaining equipment, expediting orders, designing products, and inspecting products. Notice that an activity is described by an action verb (e.g., paying or designing) and an object that receives the action (e.g., bills or products).

Cost Accumulation

Costs are incurred by an organization for a variety of purposes. Once a cost object has been identified, costs are accumulated by that object to allow us to determine its cost. The accumulation by cost object can be on the basis of individual jobs, on the basis of the processes of a particular department, on activity that is being performed, or by a responsibility centre within the company. The accumulation of costs will be based on the nature of the cost object and the nature of the company itself.

Accuracy of Cost Assignments

Assigning costs *accurately* to cost objects is crucial. Accuracy is not evaluated based on knowledge of some underlying "true" cost. Rather, it is a relative concept and has to do with the reasonableness and logic of the cost assignment methods that are being used. The objective is to measure and assign as accurately as possible the cost of the resources used by a cost object. Some cost assignment methods are clearly more accurate than others. For example, suppose you want to determine the cost of lunch for Elaine Day, a student who frequents Hideaway, an off-campus pizza parlour. One cost assignment approach is to count the number of customers at the Hideaway between 12:00 P.M. and 1:00 P.M. and then divide that into the total sales receipts earned by Hideaway during this period. Suppose that this comes to $6.25 per lunchtime customer. Based on this approach we would conclude that Elaine spends $6.25 per day for lunch. Another approach is to go with Elaine and observe how much she spends. Suppose that she has a chef's salad and a medium drink each day, costing $4.50. It is easy to see which cost assignment is more accurate. The $6.25 cost assignment is distorted by the consumption patterns of other customers (cost objects). As it turns out, most lunchtime clients order the luncheon special for $5.95 (a mini-pizza, small salad, and medium drink).

Distorted cost assignments can produce poor decisions. For example, if a plant manager is trying to decide whether to continue producing power internally or to buy it from a local utility company, then an accurate assessment of how much it is costing to produce the power internally is fundamental to the analysis. If the cost of internal power production is overstated, the manager might decide to shut down the internal power department in favour of buying power from an outside company, whereas a more accurate cost assignment might suggest the opposite. It is easy to see that poor cost assignments can prove to be costly.

Traceability

Understanding the relationship of costs to cost objects can increase the accuracy of cost assignments. Costs are directly or indirectly associated with cost objects. **Indirect costs** are costs that cannot be traced easily and accurately to a cost object. **Direct costs** are those costs that can be traced easily and accurately to a cost object.[3] For costs to be traced easily means that the costs can be assigned in an economically feasible way. For costs to be traced accurately means that the costs are assigned using a *causal relationship*. Thus, **traceability** is the ability to assign a cost directly to a cost object in an economically feasible way by means of a causal relationship. The more costs that can be traced to the object, the greater the accuracy of the cost assignments. One additional point needs to be emphasized. Cost management systems typically deal with many cost objects. Thus, it is possible for a particular cost item to be classified as both a direct cost and an indirect cost. It all depends on *which* cost object is the point of reference. For example, if the plant is the cost object, then the cost of heating and cooling the plant is a direct cost; however, if the cost objects are products produced in the plant, then this utility cost is an indirect cost.

Methods of Tracing

Traceability means that costs can be assigned easily and accurately, using a causal relationship. Tracing costs to cost objects can occur in one of two ways: (1) *direct tracing* and (2) *driver tracing*. **Direct tracing** is the process of identifying and assigning costs to a cost object that are specifically or physically associated with the cost object. Direct tracing is most often accomplished by *physical observation*. For example, assume that the power department is the cost object. The salary of the power department's supervisor and the fuel used to produce power are examples of costs that can be specifically identified (by physical observation) with the cost object (the power department). As a second example, consider a pair of blue jeans. The materials (denim, zipper, buttons, and thread) and labour (to cut the denim according to the pattern and sew the pieces together) are physically observable;

[3] This definition of direct costs is based on the glossary prepared by Computer Aided Manufacturing International Inc. (CAM-I). See Norm Raffish and Peter B. B. Turney, "Glossary of Activity-Based Management," *Journal of Cost Management* (Fall 1991): 53–63. Other terms defined in this chapter and in the text also follow the CAM-I glossary.

therefore, the costs of materials and labour can be directly charged to a pair of jeans. Ideally, all costs should be charged to cost objects using direct tracing.

Unfortunately, it is often impossible to physically observe the exact amount of resources being used by a cost object. The next best approach is to use cause-and-effect reasoning to identify factors—called *drivers*—that can be observed and that measure a cost object's resource consumption. **Drivers** are factors that *cause* changes in resource usage, activity usage, costs, and revenues. **Driver tracing** is the use of *drivers* to assign costs to cost objects. Although less precise than direct tracing, driver tracing can be accurate if the cause-and-effect relationship is sound. Consider the cost of electricity for the jeans manufacturing plant. The factory manager might want to know how much electricity is used to run the sewing machines. Physically observing how much electricity is used would require a meter to measure the power consumption of the sewing machines, which may not be practical. Thus, a driver such as "machine hours" could be used to assign the cost of electricity. If the electrical cost per machine hour is $0.10 and the sewing machines use 200,000 machine hours in a year, then $20,000 of the electricity cost ($0.10 × 200,000) would be assigned to the sewing activity. The use of drivers to assign costs to activities will be explained in more detail in Chapter 6.

Assigning Indirect Costs Indirect costs cannot be traced to cost objects. Either there is no causal relationship between the cost and the cost object, or tracing is not economically feasible. Assignment of indirect costs to cost objects is called **allocation**. Since no causal relationship exists, allocating indirect costs is based on *convenience* or some *assumed* linkage. For example, consider the cost of heating and lighting a plant that manufactures five products. Suppose that this utility cost is to be assigned to the five products. Clearly, it is difficult to see any causal relationship. A convenient way to allocate this cost is simply to assign it in proportion to the direct labour hours used by each product. Arbitrarily allocating indirect costs to cost objects reduces the overall accuracy of the cost assignments. Accordingly, the best costing policy may be that of assigning only traceable direct costs to cost objects. However, it must be admitted that allocations of indirect costs may serve other purposes besides accuracy. For example, allocating indirect costs to products may be required for external reporting. Nonetheless, most managerial uses of cost assignments are better served by accuracy. At the very least, direct and indirect cost assignments should be reported separately.

Cost Assignment Summarized There are three methods of assigning costs to cost objects: direct tracing, driver tracing, and allocation. Of the three methods, direct tracing is the most precise since it relies on physically observable causal relationships. Driver tracing relies on causal factors called drivers to assign costs to cost objects. The precision of driver tracing depends on the strength of the causal relationship described by the driver. Identifying drivers and assessing the quality of the causal relationship is more costly than either direct tracing or allocation. Allocation, while the simplest and least expensive method, is the least accurate cost assignment method; its use should be avoided where possible. In many cases, the benefits of increased accuracy by driver tracing outweigh its additional measurement cost. This cost–benefit issue is discussed more fully later in the chapter. The process really entails choosing among competing cost management systems.

Product and Service Costs

OBJECTIVE 3
Define tangible and intangible products, and explain why there are different product cost definitions.

One of the most important cost objects is the output of organizations. The two types of output are tangible products and services. **Tangible products** are goods produced by converting raw materials into finished products through the use of labour and capital inputs such as plant, land, and machinery. Televisions, hamburgers, automobiles, computers, clothes, and furniture are examples of tangible products. **Services** are tasks or activities performed for a customer or an activity performed by a customer

using an organization's products or facilities. Services are also produced using materials, labour, and capital inputs. Insurance coverage, medical care, dental care, funeral care, and accounting are examples of service activities performed for customers. Car rental, video rental, and skiing are examples of services where the customer uses an organization's products or facilities.

Services differ from tangible products on three important dimensions: intangibility, perishability, and inseparability. **Intangibility** means that buyers of services cannot see, feel, hear, or taste a service before it is bought. Thus, services are *intangible products.* **Perishability** means that services cannot be stored (there are a few unusual cases where tangible goods cannot be stored). Finally, **inseparability** means that producers of services and buyers of services must usually be in direct contact for an exchange to take place. In effect, services are often inseparable from their producers. For example, an eye examination requires both the patient and the optometrist to be present. However, producers of tangible products need not have direct contact with the buyers of their goods. Buyers of automobiles, for instance, never need to have contact with the engineers and assembly line workers who produce automobiles.

Organizations that produce tangible products are called *manufacturing* organizations. Those that produce intangible products are called *service* organizations. Managers of organizations that produce goods or services need to know how much individual products cost for a number of reasons, including profitability analysis and strategic decisions concerning product design, pricing, and product mix.

For example, **McDonald's Corporation** needed to know the cost of individual products to determine whether to keep them on the Dollar Menu. The double cheeseburger, a very popular item, rose in cost to well over $1. Many franchisees refused to sell the item as part of the Dollar Menu—some charging over $2 for it.[4] In late 2008, McDonald's exchanged the double cheeseburger for a double hamburger with just one slice of cheese. This change made it possible for its franchisees to continue to offer a well rounded Dollar Menu without taking the guaranteed loss incurred every time a double cheeseburger was sold at less than cost.

Service companies also relate cost to profit.

A number of professional sports teams, including the **Toronto Maple Leafs**, have gone the extra mile to keep season ticket holders happy. Realizing that there are numerous competing entertainment options, they have hired hospitality specialists and concierges to offer more services to season ticket holders. These additional services may include special tours of the locker room or chances to speak to upper management about their concerns. While the additional services are not cheap, they are an important part of maintaining consistent revenue even in the face of a disappointing win-loss record.[5]

Given the importance of cost to both manufacturing and service firms, when we discuss product costs, we are referring to both intangible and tangible products.

Product Costs and External Financial Reporting

An important objective of a cost management system is the calculation of product costs for external financial reporting. Externally imposed conventions require costs to be classified in terms of the special purposes, or functions, they serve. Costs are subdivided into two major functional categories: production and nonproduction. **Production (or product) costs** are those costs associated with manufacturing goods or providing services. **Nonproduction costs** are those costs associated with the functions of selling and administration. For tangible goods, production and nonproduction costs are often referred to as *manufacturing costs* and *nonmanufacturing costs*, respectively. Production costs can be further classified as *direct materials*, *direct*

[4] Richard Gibson, "Franchisees Balk at Dollar Menu," *The Wall Street Journal* (November 14, 2007): B3f.

[5] Adam Thompson, "The Nosebleed VIPs," *The Wall Street Journal* (March 19, 2007): B1 (adapted).

labour, and *overhead*. Only these three cost elements can be assigned to products for external financial reporting.

Direct Materials **Direct materials** are those materials traceable to the good or service being produced. The cost of these materials can be directly charged to products because physical observation can be used to measure the quantity used by each product. Materials that become part of a tangible product or those materials that are used in providing a service are usually classified as direct materials. For example, steel in an automobile, wood in furniture, alcohol in cologne, denim in jeans, braces for correcting teeth, surgical gauze and anesthesia for an operation, ribbon in a corsage, and soft drinks on an airline are all direct materials.

Direct Labour **Direct labour** is labour that is traceable to the goods or services being produced. As with direct materials, physical observation is used to measure the quantity of labour used to produce a product or service. Employees who convert raw materials into a product or who provide a service to customers are classified as direct labour. Workers on an assembly line at Research In Motion, a chef in a restaurant, a surgical nurse for an open-heart operation, and a pilot for **Air Canada** are examples of direct labour.

Overhead All production costs other than direct materials and direct labour are lumped into one category called **overhead**. In a manufacturing firm, overhead is also known as *factory burden* or *manufacturing overhead*. The overhead cost category contains a wide variety of items. Many inputs other than direct labour and direct materials are needed to produce products. Examples include depreciation on buildings and equipment, maintenance, supplies, supervision, materials handling, power, property taxes, landscaping of factory grounds, and plant security. **Supplies** are generally those materials necessary for production that do not become part of the finished product or are not used in providing a service. Dishwasher detergent in a fast-food restaurant and oil for production equipment are examples of supplies.

Direct materials that form an insignificant part of the final product are usually lumped into the overhead category called **indirect materials**. This treatment is justified on the basis of cost and convenience. The cost of the tracing is greater than the benefit of increased accuracy. The glue used in making furniture or toys is an example.

The cost of overtime for direct labour is usually assigned to overhead as well. The rationale is that typically no particular production run caused the overtime. Accordingly, overtime cost is common to all production runs and is therefore an indirect manufacturing cost. Note that *only* the overtime cost itself is treated this way. If workers are paid $16 per hour regular rate and a premium of $8 per overtime hour, then only the $8 overtime premium is assigned to overhead. The $16 regular rate is still regarded as a direct labour cost. In certain cases, however, overtime is associated with a particular production run, such as a special order taken when production is at 100 percent capacity. In these special cases, it is appropriate to treat overtime premiums as a direct labour cost.

Prime and Conversion Costs The manufacturing and nonmanufacturing classifications give rise to some related cost concepts. The functional distinction between manufacturing and nonmanufacturing costs is the basis for the concepts of inventoriable costs and noninventoriable costs—at least for purposes of external reporting. Combinations of different production costs also produce the concepts of prime costs and conversion costs.

Prime cost is the sum of direct materials cost and direct labour cost. **Conversion cost** is the sum of direct labour cost and overhead cost. For a manufacturing firm, conversion cost can be interpreted as the cost of converting raw materials into a final product. Cornerstone 1-1 shows how and why to calculate prime cost, conversion cost, and product cost.

CORNERSTONE 1-1

The HOW and WHY of Calculating Prime Cost, Conversion Cost, Variable Product Cost, and Total Product Cost

Information:

Carreker Company manufactures cell phones. For next year, Carreker predicts that 30,000 units will be produced, with the following total costs:

Direct materials	$150,000
Direct labour	90,000
Variable overhead	30,000
Fixed overhead	450,000

Why:

Product costs are basic to management control and decision making. Managers use these costs for budgeting to check the impact of an increase or a decrease in unit sales on operating income. Since fixed costs stay the same when units change, knowledge of prime cost, conversion cost, variable product cost, and overall product cost give important information, allowing analysis of costs at differing levels of production.

Required:

1. Calculate the prime cost per unit.
2. Calculate the conversion cost per unit.
3. Calculate the total variable product cost per unit.
4. Calculate the total product (manufacturing) cost per unit.
5. ***What if*** 32,000 cell phones could be manufactured next year? Explain in words how that would affect the unit prime cost, the unit conversion cost, the unit variable product cost, and the unit total product cost.

Solution:

1. Unit prime cost = (Direct materials + Direct labour)/Number of units
   = ($150,000 + $90,000)/30,000
   = $8

2. Unit conversion cost = (Direct labour + Overhead)/Number of units
   = ($90,000 + $30,000 + $450,000)/30,000
   = $19

3. Unit variable product cost = (Direct materials + Direct labour + Variable overhead)/Number of units
   = ($150,000 + $90,000 + $30,000)/30,000
   = $9

4. Unit product cost = (Direct materials + Direct labour + Variable overhead + Fixed overhead)/Number of units
   = ($150,000 + $90,000 + $30,000 + $450,000)/30,000
   = $24

5. If the number of units produced increases, there will be no impact on any unit variable cost. Thus, unit prime cost and unit variable cost would stay the same. However, unit conversion cost and unit product cost would go down due to the presence of fixed factory overhead. Fixed overhead will remain the same in total, but decrease per unit as the number of units goes up. Conversely, if the number of units goes down, unit fixed overhead will increase.

Nonproduction Costs Nonproduction costs are divided into two categories: marketing (selling) costs and administrative costs. Marketing and administrative costs are not inventoried and are called *period* costs. **Period costs** are expensed in the period in which they are incurred. Thus, period costs are not inventoried and are not assigned to products. Period costs appear on the income statement—not the balance sheet. In a manufacturing organization, the level of these costs can be significant (often greater than 25 percent of sales revenue), and controlling them may bring greater cost savings than the same control exercised in the area of production costs.

Procter & Gamble spends enormous amounts on advertising in order to develop and dominate the market for shampoo and detergent in China. P&G buys more air time each month than even the most media-conscious Chinese companies spend in a year. Couple that with the cost of free samples and salaries for the thousands of Chinese who distribute them, we see that marketing expense in China is a significant portion of P&G's budget.[6]

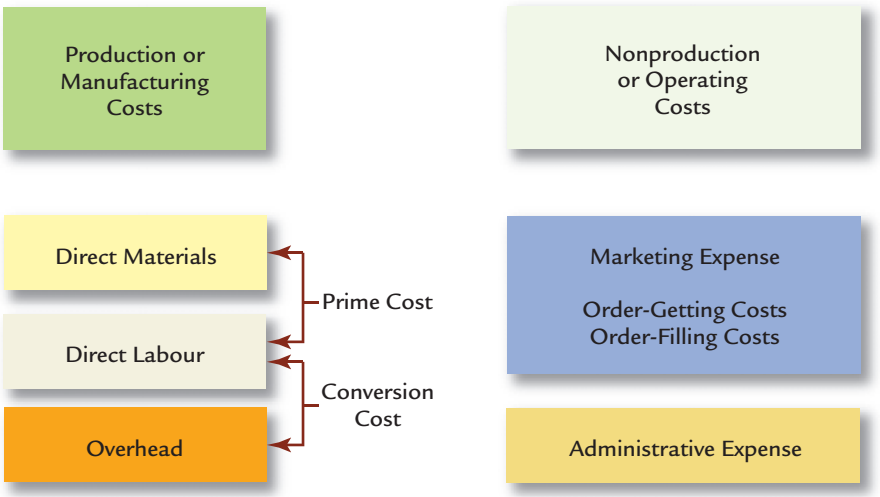
For service organizations, the relative importance of selling and administrative costs depends on the nature of the service being produced. Physicians and dentists, for example, generally do very little marketing and thus have very low selling costs. An airline, on the other hand, may incur substantial marketing costs.

Those costs necessary to market and distribute a product or service are **marketing (selling) costs**. They are often referred to as *order-getting* and *order-filling* costs. Examples of marketing costs include the following: salaries and commissions of sales personnel, advertising, warehousing, shipping, and customer service. The first two items are examples of order-getting costs; the last three are order-filling costs.

All costs that cannot be reasonably assigned to either marketing or production are **administrative costs**. Administration is responsible for ensuring that the various activities of the organization are properly integrated in accordance with the overall mission of the firm. The president of the firm, for example, is concerned with the efficiency of *both* marketing and production as they carry out their respective roles. Proper integration of these two functions is essential for maximizing the overall profits of a firm. Examples of administrative costs are top-executive salaries, legal fees, printing and distributing the annual report, and general accounting. Research and development is also part of administrative costs, and is usually expensed in the period incurred. Exhibit 1-3 illustrates the various types of production and nonproduction costs.

Exhibit 1-3

Production and Nonproduction Costs



[6] Joseph Kahn, "P&G Viewed China as a National Market and Is Conquering It," *The Wall Street Journal* (September 12, 1995): A1, A6.

OBJECTIVE 4
Prepare income statements for manufacturing and service organizations.

Financial Statements

The functional classification is the cost classification required for external reporting. In preparing an income statement, production and nonproduction costs are separated. The reason for the separation is that production costs are product costs—costs that are inventoried until the units are sold—and the nonproduction costs of marketing and administration are viewed as period costs. Thus, production costs attached to the units sold are recognized as an expense (cost of goods sold) on the income statement. Production costs attached to units that are not sold are reported as inventory on the balance sheet. Marketing and administrative expenses are viewed as costs of the period and must be deducted each and every period as expenses on the income statement. Nonproduction costs never appear on the balance sheet.

Income Statement: Manufacturing Firm

The income statement prepared for external parties follows the standard format taught in an introductory financial accounting course. This income statement is frequently referred to as **absorption-costing income** or **full-costing income** because *all* manufacturing costs (direct materials, direct labour, and overhead) are fully assigned to the product.

Under the absorption-costing approach, expenses are separated according to function and then deducted from revenues to arrive at operating income. The two major functional categories of expense are cost of goods sold and operating expenses. These categories correspond to a firm's manufacturing and nonmanufacturing (marketing and administrative) expenses. **Cost of goods sold** is the cost of direct materials, direct labour, and overhead attached to the units sold. To compute the cost of goods sold, it is first necessary to determine the cost of goods manufactured.

Cost of Goods Manufactured

The **cost of goods manufactured** represents the total manufacturing cost of goods completed during the current period. The only costs assigned to goods completed are the manufacturing costs of direct materials, direct labour, and overhead. The details of this cost assignment are given in a supporting schedule, called the *statement of cost of goods manufactured*. Cornerstone 1-2 shows how to create the statement of cost of goods manufactured.

Notice in Cornerstone 1-2 that the *total manufacturing costs* of the period are added to the manufacturing costs found in beginning work in process. The costs found in ending work in process are then subtracted to arrive at the cost of goods manufactured. If the cost of goods manufactured is for a single product, then the average unit cost can be computed by dividing the cost of goods manufactured by the number of units produced. For example, for Carreker Company, the average cost per unit of cell phones is about $24.64 ($739,300/30,000).

Work in process consists of all partially completed units found in production at a given point in time. Beginning work in process consists of the partially completed units on hand at the beginning of a period. Ending work in process consists of the incomplete units on hand at the period's end. In the statement of cost of goods manufactured, the cost of these partially completed units is reported as the cost of beginning work in process and the cost of ending work in process. The cost of beginning work in process represents the manufacturing costs carried over from the prior period; the cost of ending work in process represents the manufacturing costs that will be carried over to the next period. In both cases, additional manufacturing costs must be incurred to complete the units in work in process.

Cost of Goods Sold

Once the cost of goods manufactured statement is prepared, the cost of goods sold can be computed. The cost of goods sold is the manufacturing cost of the units that were sold during the period. It is important to remember that the cost of goods sold may or may not equal the cost of goods manufactured. In addition, we must remember that the cost of goods sold is an expense,

The HOW and WHY of Preparing the Statement of Cost of Goods Manufactured

CORNERSTONE 1-2

Information:

Carreker Company manufactures cell phones. For next year, Carreker predicts that 30,000 units will be produced, with the following total costs:

Direct materials	$154,300
Direct labour	90,000
Variable overhead	30,000
Fixed overhead	450,000

Carreker expects to purchase $147,900 of direct materials next year. Projected beginning and ending inventories for direct materials and work in process are as follows:

	Direct Materials Inventory	Work-in-Process Inventory
Beginning	$53,400	$75,000
Ending	47,000	60,000

Why:

The primary use for the statement of cost of goods manufactured is for external financial reporting. It is a crucial input to the statement of cost of goods sold and to the income statement.

Required:

1. Prepare a statement of cost of goods manufactured in good form.
2. ***What if*** 32,000 cell phones were to be manufactured next year? Explain which lines of the statement of cost of goods manufactured would be affected and how.

Solution:

1.

Carreker Company
Statement of Cost of Goods Manufactured
For the Coming Year

Direct materials		
Beginning inventory	$ 53,400	
Add: Purchases	147,900	
Materials available	201,300	
Less: Ending inventory	47,000	
Direct materials used in production		$154,300
Direct labour		90,000
Manufacturing (factory) overhead		480,000
Total manufacturing costs added		724,300
Add: Beginning work in process		75,000
Less: Ending work in process		60,000
Cost of goods manufactured		$739,300

CORNERSTONE 1-2 *(continued)*

2. If the number of units produced increases, the cost of direct materials used in production will increase. Since there are sufficient direct materials in beginning inventory, it is not clear whether purchases would increase, or instead, if ending materials inventory would go down. Direct labour would increase to reflect the additional units. Overhead would increase due to the increase in variable overhead, but the fixed overhead component would remain the same. No clear need for changes in beginning and ending WIP are required as long as the additional 2,000 units come from current production.

and it belongs on the income statement. Cornerstone 1-3 shows the cost of goods sold schedule for a manufacturing company.

Finally, we are ready to prepare an income statement for a manufacturing firm. Cornerstone 1-4 shows how the results of the statement of cost of goods sold are included with nonmanufacturing expenses to calculate operating income. Gross margin, also called gross profit, (the difference between sales and cost of goods sold) is an important number on the income statement.

Often, the income statement includes a column showing each line item as a percentage of sales. Clearly, sales is 100 percent of sales. Management can review these percentages and compare them with past history of the firm and with industry averages to see whether expenses are in line with expectations. If the industry generally spends 15 percent of sales on selling expense, then a company that spends significantly more or less than that amount may want to carefully consider whether its marketing strategy is appropriate.

Income Statement: Service Organization

The income statement for a service organization looks very similar to the one shown in Cornerstone 1-4 for a manufacturing organization. However, the cost of goods sold does differ in some key ways. For one thing, the service firm has no finished goods inventories since services cannot be stored, although it is possible to have work in process for services. For example, an architect may have drawings in process and an orthodontist may have numerous patients in various stages of processing for braces. Additionally, some service firms add order fulfillment costs to the cost of goods sold.

The Role of the Management Accountant

World-class firms are those that are at the cutting edge of customer support. They know their market and their product. They strive continually to improve product design, manufacture, and delivery. These companies can compete with the best of the best in a global environment. Accountants, too, can be termed world class. Those who merit this designation are intelligent and well prepared. They not only have the education and training to accumulate and provide financial information, but they stay up to date in their field and in business. In addition, world-class accountants must be familiar with the customs and financial accounting rules of the countries in which their firm operates.

The Controller The **controller**, the chief accounting officer, supervises all accounting departments. Because of the critical role that management accounting plays in the operation of an organization, the controller is often viewed as a member of the top management team and encouraged to participate in planning, controlling, and decision-making activities. As the chief accounting officer, the controller has responsibility for both internal and external accounting requirements. This charge may include direct responsibility for internal auditing, cost accounting, financial accounting (including securities commission reports and financial statements), systems accounting (including analysis, design, and internal controls), budgeting support, economic

The HOW and WHY of Preparing the Statement of Cost of Goods Sold

CORNERSTONE 1-3

Information:

Carreker Company manufactures cell phones. For next year, Carreker predicts that 30,000 units will be produced with the following total costs:

Direct materials	$154,300
Direct labour	90,000
Variable overhead	30,000
Fixed overhead	450,000

Carreker expects to purchase $147,900 of direct materials next year. Projected beginning and ending inventories for direct materials and work in process are as follows:

	Direct Materials Inventory	Work-in-Process Inventory
Beginning	$53,400	$75,000
Ending	47,000	60,000

Carreker Company expects to sell 34,000 units. Beginning inventory of finished goods is expected to be $151,000, and ending inventory of finished goods is expected to be $45,000.

Why:

The primary use for the statement of cost of goods sold is for external financial reporting. It is a crucial input to the income statement.

Required:

1. Prepare a statement of cost of goods sold in good form.
2. ***What if*** only 32,000 cell phones were to be sold next year? Explain which lines of the statement of cost of goods sold would be affected and how.

Solution:

1.

Carreker Company
Statement of Cost of Goods Sold
For the Coming Year

Cost of goods manufactured (Cornerstone 1-2)	$739,300
Add: Beginning finished goods	151,000
Cost of goods available for sale	890,300
Less: Ending finished goods	45,000
Cost of goods sold	845,300

2. If the number of units sold decreases, and production remains the same, then ending finished goods will be higher as the unsold units remain in inventory.

analysis, and taxes. The duties and organization of the controller's office vary from firm to firm. In some companies, the internal audit department may report directly to the financial vice president; similarly, the systems department may report directly to the financial vice president or even to another staff vice president.

CORNERSTONE 1-4

The HOW and WHY of Preparing the Income Statement for a Manufacturing Firm

Information:

Carreker Company manufactures cell phones. For next year, Carreker predicts that 30,000 units will be produced with the following total costs:

Direct materials	$154,300
Direct labour	90,000
Variable overhead	30,000
Fixed overhead	450,000

Carreker expects to purchase $147,900 of direct materials next year. Projected beginning and ending inventories for direct materials and work in process are as follows:

	Direct Materials Inventory	Work-in-Process Inventory
Beginning	$53,400	$75,000
Ending	47,000	60,000

Carreker Company expects to sell 34,000 units at a price of $35 each. Beginning inventory of finished goods is expected to be $151,000, and ending inventory of finished goods is expected to be $45,000. Total selling expense is projected at $62,000, and total administrative expense is projected at $187,000.

Why:

The primary use for the income statement is for external financial reporting. Investors and outside parties use it to determine the financial health of a firm.

Required:

1. Prepare an income statement in good form. Give percentages of sales for each major line item.
2. ***What if*** only 32,000 cell phones were to be sold next year? Explain which lines of the income statement would be affected and how.

Solution:

1.

Carreker Company
Income Statement
For the Coming Year

			%
Sales ($35 × 34,000)		$1,190,000	100.00
Less: Cost of goods sold (Cornerstone 1-3)		845,300	71.03
Gross margin		344,700	28.97
Less operating expenses:			
Selling expenses	$ 62,000		
Administrative expenses	187,000	249,000	20.92
Operating income		$ 95,700	8.04*

*Difference is due to rounding.

2. If the number of units sold decreases, both sales and cost of goods sold will decrease, as will gross margin. Since no variable elements have been noted for selling and administrative expense, it is assumed that they are fixed and will not change if sales volume changes. Operating income will decrease.

CORNERSTONE 1-4 *(continued)*

The Treasurer The **treasurer** is responsible for the finance function. Specifically, the treasurer raises capital and manages cash (banking and custody), investments, and investor relations. The treasurer may also be in charge of credit and collections as well as insurance. The treasurer reports to the financial vice president.

Information for Planning, Controlling, Continuous Improvement, and Decision Making

The cost and management accountant is responsible for generating financial information required by the firm for internal and external reporting. This involves responsibility for collecting, processing, and reporting information that will help managers in their planning, controlling, and other decision-making activities.

Planning The detailed formulation of future actions to achieve a particular end is the management activity called **planning**. Planning therefore requires setting objectives and identifying methods to achieve those objectives. A firm may have the objective of increasing its short- and long-term profitability by improving the overall quality of its products. By improving product quality, the firm should be able to reduce scrap and rework, decrease the number of customer complaints and the amount of warranty work, reduce the resources currently assigned to inspection, and so on, thus increasing profitability. This is accomplished by working with suppliers to improve the quality of incoming raw materials, establishing quality control circles, and studying defects to ascertain their cause.

Controlling The processes of monitoring a plan's implementation and taking corrective action as needed are referred to as **controlling**. Control is usually achieved with the use of **feedback**. Feedback is information that can be used to evaluate or correct the steps that are actually being taken to implement a plan. Based on the feedback, a manager may decide to let the implementation continue as is, take corrective action of some type to put the actions back in harmony with the original plan, or do some midstream replanning.

Feedback is a critical facet of the control function. It is here that accounting once again plays a vital role. Accounting reports that provide feedback by comparing planned (budgeted) data with actual data are called **performance reports**. Exhibit 1-4 shows a performance report that compares budgeted sales and cost of goods sold with the actual amounts for the month of August. Deviations from the planned amounts that increase profits are labelled "favourable," while those that decrease profits are called "unfavourable." These performance reports can have a dramatic impact on managerial actions—but they must be realistic and supportive of management plans. Revenue and spending targets must be based (as closely as possible) on actual operating conditions.

Continuous Improvement In a dynamic environment, firms must continually improve their performance to remain competitive or to establish a competitive advantage. A company pursuing continuous improvement has the goal of performing better than before and better than competitors. **Continuous improvement** has been defined as "the relentless pursuit of improvement in the delivery of value to customers."[7] In practical terms, continuous improvement means searching for ways to increase overall efficiency by reducing waste, improving quality, and reducing costs. Cost management

[7] W. Maguire and D. Heath, "Capacity Management for Continuous Improvement," *Journal of Cost Management* (January 1997): 26–31.

Exhibit 1-4

Performance Report Illustrated

Golding Foods Inc.
Performance Report
For the Month Ended August 31, 2011

Budget Item	Actual	Budgeted	Variance
Sales	$800,000	$900,000	$100,000 U
Cost of goods sold	600,000	650,000	50,000 F

Note: U = Unfavourable; F = Favourable.

supports continuous improvement by providing information that helps identify ways to improve and then reports on the progress of the methods that have been implemented. It also plays a critical role by developing a control system that locks in and maintains any improvements realized.

Decision Making The process of choosing among competing alternatives is **decision making**. Decisions can be improved if information about the alternatives is gathered and made available to managers. One of the major roles of the accounting information system is to supply information that facilitates decision making. This pervasive managerial function is an important part of both planning and control. A manager cannot plan without making decisions. Managers must choose among competing objectives and methods to carry out the chosen objectives. Only one of numerous mutually exclusive plans can be chosen. Similar comments can be made concerning the control function.

Certification in Management Accounting

In 1920, the Canadian Society of Cost Accountants, the predecessor of CMA Canada, was incorporated in Hamilton, Ontario. In 1941, the Registered Industrial Accountant (RIA) program was established, which evolved into the Certified Management Accountant program in 1985. A **Certified Management Accountant (CMA)** has passed a rigorous qualifying examination, has met an experience requirement, and participates in continuing education.

One of the main purposes of creating the CMA program was to establish management accounting as a recognized, professional discipline, separate from the profession of public accounting. Since its inception, the CMA program has been very successful. Many firms now sponsor and pay for classes that prepare their management accountants for the qualifying examination, as well as provide other financial incentives to encourage acquisition of the CMA certificate.

OBJECTIVE 5
Understand the importance of ethical behaviour for management accountants.

Ethical Behaviour

Virtually all managerial accounting practices were developed to assist managers in maximizing profits. Traditionally, actions regarding the economic performance of the firm have been the overriding concern. Yet managers and managerial accountants should not become so focused on profits that they develop a belief that the only goal of a business is maximizing its net worth. The objective of profit maximization should be constrained by the requirement that profits be achieved through legal and ethical means. While this has always been an implicit assumption of managerial accounting, the assumption should be made explicit. To help achieve this objective, many of the problems in this text require explicit consideration of ethical issues.

Ethical behaviour involves choosing actions that are right, proper, and just. Behaviour can be right or wrong; it can be proper or improper; and the decisions we

make can be fair or unfair. Though people often differ in their views of the meaning of the ethical terms cited, there seems to be a common principle underlying all ethical systems. This principle is expressed by the belief that each member of a group bears some responsibility for the well-being of other members. Willingness to sacrifice one's self-interest for the well-being of the group is the heart of ethical action.

This notion of sacrifice produces some core values—values that describe what is meant by right and wrong in more concrete terms. James W. Brackner, writing for the "Ethics Column" in *Management Accounting*, made the following observation:

> *For moral or ethical education to have meaning, there must be agreement on the values that are considered "right." Ten of these values are identified and described by Michael Josephson in "Teaching Ethical Decision Making and Principled Reasoning." The study of history, philosophy, and religion reveals a strong consensus as to certain universal and timeless values essential to the ethical life.*
>
> *These 10 core values yield a series of principles that delineate right and wrong in general terms. Therefore, they provide a guide to behaviour.*[8]

The 10 core values referred to in the quotation include the following:

1. Honesty
2. Integrity
3. Promise keeping
4. Fidelity
5. Fairness
6. Caring for others
7. Respect for others
8. Responsible citizenship
9. Pursuit of excellence
10. Accountability

Many of the well-known accounting scandals, such as those involving **Adelphia**, **WorldCom**, **HealthSouth**, and **Parmalat**, provide evidence of the pressures faced by top managers and accountants to produce large net income numbers, especially in the short term. Unfortunately, such individuals often give into these pressures when faced with questionable revenue- and cost-related judgments. For example, the scandal at WorldCom was committed because the CEO, Bernie Ebbers, coerced several of the top accountants at WorldCom to wrongfully record journal entries in the company's books that capitalized millions of dollars in costs as assets (i.e., on the balance sheet) rather than as expenses (i.e., on the income statement) that would have dramatically lowered current period net income. Eventually, WorldCom was forced to pay hundreds of millions of dollars to the U.S. government and to shareholders for its illegal and unethical actions. In addition, several of the top executives were sentenced to extensive prison time for their actions. The recent subprime mortgage crisis also highlights the importance of ethical considerations as some banks tried to increase their profits either by lending individuals more money than they could reasonably afford or using terms that were intentionally less clear, or transparent, than many outsiders thought they should be.[9]

As some of these examples point out, though it may seem contradictory, sacrificing self-interest for the collective good might not only be right and bring a sense of individual worth but might also make good business sense. Companies with a strong code of ethics can create strong customer and employee loyalty. While liars and cheats may win on occasion, their victories often are short-lived. Companies in business for the long term find that it pays to treat all of their constituents with honesty and loyalty.

[8] James W. Brackner, "Consensus Values Should Be Taught," *Management Accounting* (August 1992): 19. For a more complete discussion of the 10 core values, see also Michael Josephson, *Teaching Ethical Decision Making and Principled Reasoning, Ethics Easier Said Than Done* (The Josephson Institute, Winter Los Angeles, CA: 1988): 29–30.

[9] Jane Sasseen, "FBI Widens Net Around Subprime Industry: With 14 Companies Under Investigation, the Bureau's Scope is the Entire Securitization Process," *Business Week Online* (January 30, 2008). Taken from http://www.businessweek.com/bwdaily/dnflash/content/jan2008/db20080129_728982.htm?chan=search on February 12, 2008.

Company Codes of Ethical Conduct

To promote ethical behaviour by managers and employees, organizations commonly establish standards of conduct referred to as Company Codes of Conduct. One needs only to hear the name "Enron" to be reminded of the importance of ethical conduct.

In 2009, **Loblaws Companies** outlined its approach to social responsibility and expressed its achievements and core values in a Corporate Social Responsibility Report (CSR). That document linked the company to five core values:

- Respecting the environment
- Sourcing with integrity
- Making a positive difference in the community
- Reflecting the nation's diversity
- Being a great place to work

Reflecting those values, in 2009, Loblaws implemented the following:

- *Plastic bag diversion:* It applied a national 5-cent charge for every plastic bag provided at checkout. This led to more than 1.3 billion plastic bags being diverted from Canadian landfills by the end of 2009.
- *Improved fuel efficiency:* In its efforts to reduce its carbon footprint, it achieved a 2 percent improvement in transport fleet fuel efficiency per kilometre.
- *Sourcing with integrity:* The company committed itself to sustainably sourcing 100 percent of all seafood sold in its stores by year end 2013.

In addition, Loblaws did the following:

- Reduced its national refrigerant leak rate by 5 percent as a result of 56 corporate banner stores having alternative refrigeration systems that significantly reduced refrigerant requirements.
- Established a target to reduce nonrecyclable packaging on private label brands by 50 percent by 2013. Once this is achieved, the company's packaging will be 79 percent recyclable.
- Installed a wind turbine at the Atlantic Superstore in Porters Lake, Nova Scotia.
- Granted $8.9 million to more than 1,500 families across Canada through the President's Choice Children's Charity.
- Announced corporate donations of more than $24 million to help support local charities, programs, and organizations across Canada.
- Grew sales of Canadian produce by 16 percent during its Grown Close to Home campaign.
- Reduced sodium content in more than 50 private label products.
- Increased the number of female store managers by 53.7 per cent (since 2008).[10]

Important parts of corporate codes of conduct are integrity, performance of duties, and compliance with the rule of law. They also uniformly prohibit the acceptance of kickbacks and improper gifts, insider trading, and misappropriation of corporate information and assets.

Standards of Ethical Conduct for Managerial Accountants

Organizations commonly establish standards of conduct for their managers and employees. Professional associations also establish ethical standards. All three Canadian accounting bodies: Canadian Institute of Chartered Accountants (CICA), Certified Management Accountants (CMA), and **Certified General Accountants (CGA)**—have established ethical standards for accountants. Professional accountants are bound by these codes of conduct, which stress the importance of competence, confidentiality, integrity, and credibility or objectivity. The CMA Code of Professional Ethics is provided in Exhibit 1-5.

[10] © 2010 Loblaw Inc. Reproduced with permission. http://www.loblaw.com/Theme/Loblaw/files/en/csr_2009/targets.htm.

Exhibit 1-5

*CMA Code of Professional Ethics**

All Members, Students, Firms, Public Accounting Firms and Professional Corporations will adhere to the following Code of Professional Ethics of CMA Ontario:

A Member, Student, Firm, Public Accounting Firm or Professional Corporation will act at all times with:

(a) responsibility for and fidelity to public needs;
(b) fairness and loyalty to such Member's, Student's, Firm's, Public Accounting Firm's or Professional Corporation's associates, clients and employers; and
(c) competence through devotion to high ideals of personal honour and professional integrity.

A Member, Student, Firm, Public Accounting Firm or Professional Corporation will:

(a) maintain at all times independence of thought and action;
(b) not express an opinion on financial reports or statements without first assessing her, his or its relationship with her, his or its client to determine whether such Member, Student, Firm, Public Accounting Firm or Professional Corporation might expect her or his opinion to be considered independent, objective and unbiased by one who has knowledge of all the facts;
(c) when preparing financial reports or statements or expressing an opinion on financial reports or statements, disclose all material facts known to such Member, Student, Firm, Public Accounting Firm or Professional Corporation in order not to make such financial reports or statements misleading, acquire sufficient information to warrant an expression of opinion and report all material misstatements or departures from generally accepted accounting principles; and
(d) comply with the requirements of the CMA Ontario Independence Regulation for Assurance, Audit and Review Engagements.

A Member, Student, Firm, Public Accounting Firm or Professional Corporation will:

(a) not disclose or use any confidential information concerning the affairs of such Member's, Student's, Firm's, Public Accounting Firm's or Professional Corporation's employer or client unless authorized to do so or except when such information is required to be disclosed in the course of any defence of himself, herself or itself or any associate or employee in any lawsuit or other legal proceeding or against alleged professional misconduct by order of lawful authority of the Board or any Committee of CMA Ontario in the proper exercise of their duties but only to the extent necessary for such purpose and only as permitted by law;
(b) obtain, at the outset of an engagement, written agreement from any party or parties to whom work is contracted not to disclose or use any confidential information concerning the affairs of such Member's, Student's, Firm's, Public Accounting Firm's or Professional Corporation's employer or client unless authorized to do so or except when such information is required to be disclosed in the course of any defence of himself, herself or itself or any associate or employee in any lawsuit or other legal proceeding but only to the extent necessary for such purpose and only as permitted by law;
(c) inform his, her or its employer or client of any business connections or interests of which such Member's, Student's, Firm's, Public Accounting Firm's or Professional Corporation's employer or client would reasonably expect to be informed;
(d) not, in the course of exercising his, her or its duties on behalf of such Member's, Student's, Firm's, Public Accounting Firm's or Professional Corporation's employer or client, hold, receive, bargain for or acquire any fee, remuneration or benefit without such employer's or client's knowledge and consent; and
(e) take all reasonable steps, in arranging any engagement as a consultant, to establish a clear understanding of the scope and objectives of the work before it is commenced and will furnish the client with an estimate of cost, preferably before the engagement is commenced, but in any event as soon as possible thereafter.

A Member, Student, Firm, Public Accounting Firm or Professional Corporation will:

(a) conduct himself, herself or itself toward Members, Students, Firms, Public Accounting Firms and Professional Corporations with courtesy and good faith;
(b) not commit an act discreditable to the profession;
(c) not engage in or counsel any business or occupation which, in the opinion of CMA Ontario, is incompatible with the professional ethics of a management accountant or public accountant;
(d) not accept any engagement to review the work of a Member, Student, Firm, Public Accounting Firm or Professional Corporation for the same employer except with the knowledge of that Member, Student, Firm, Public Accounting Firm or Professional Corporation, or except where the connection of that Member, Student, Firm, Public Accounting Firm or Professional Corporation with the work has been terminated, unless the Member, Student, Firm, Public Accounting Firm or Professional Corporation reviews the work of others as a normal part of his, her or its responsibilities;
(e) not attempt to gain an advantage over Members, Students, Firms, Public Accounting Firms and Professional Corporations by paying or accepting a commission in securing management accounting or public accounting work;
(f) uphold the principle of adequate compensation for management accounting and public accounting work; and
(g) not act maliciously or in any other way which may adversely reflect on the public or professional reputation or business of a Member, Student, Firm, Public Accounting Firm or Professional Corporation.

A Member, Student, Firm, Public Accounting Firm or Professional Corporation will:

(a) at all times maintain the standards of competence expressed by the Board from time to time;
(b) disseminate the knowledge upon which the profession of management accounting is based to others within the profession and generally promote the advancement of the profession;
(c) undertake only such work as he, she or it is competent to perform by virtue of his, her or its training and experience and will, where it would be in the best interests of an employer or client, engage, or advise the employer or client to engage, other specialists;
(d) expose before the proper tribunals of CMA Ontario any incompetent, unethical, illegal or unfair conduct or practice of a Member, Student, Firm, Public Accounting Firm or Professional Corporation which involves the reputation, dignity or honour of CMA Ontario; and
(e) endeavour to ensure that a professional partnership, company or individual, with which such Member, Student, Firm, Public Accounting Firm or Professional Corporation is associated as a partner, principal, director, officer, associate or employee, abides by the Code of Professional Ethics and the Rules of Professional Conduct established by CMA Ontario.

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One of the key requirements for obtaining the CMA certificate or designation is passing a qualifying examination. Four areas are emphasized: (1) business analysis; (2) management accounting and reporting; (3) strategic management; and (4) business applications. The parts to the examination reflect the needs of management accounting and underscore the earlier observation that management accounting has more of an interdisciplinary flavour than other areas of accounting.

Summary of Learning Objectives

1. Describe a cost management information system, its objectives, and its major subsystems, and indicate how it relates to other operating and information systems.

- Cost management system, a subsystem of the accounting information system, designed to satisfy costing, controlling, and decision-making objectives
- Two major subsystems: cost accounting system and the operational control system

2. Explain the cost assignment process.

- Objective of the cost accounting system is assigning costs to cost objects
- Three methods of cost assignment:
  - Direct tracing—physical observation, most accurate
  - Driver tracing—more expensive, more accurate than allocation
  - Allocation—least accurate, easiest to apply

3. Define tangible and intangible products, and explain why there are different product cost definitions.

- Products are tangible.
- Services are:
  - Intangible
  - Perishable (cannot be inventoried)
  - Inseparable (buyer and provider interact)
- Product cost definitions:
  - Value chain includes research and development, production, marketing, and customer service. Used for pricing decisions, product mix decisions, strategic profitability analysis.
  - Operating product costs include production, marketing, and customer service. Used for strategic design decisions, tactical profitability analysis.
  - Traditional product costs include only production (direct materials, direct labour, overhead) and are used for external financial reporting.

4. Prepare income statements for manufacturing and service organizations.

- Income statements rely on:
  - Cost of goods manufactured or services provided
  - Cost of goods sold or services sold (typically the same as services provided)
- Gross margin is the difference between sales revenue and the cost of goods (or services) sold.
- Operating income is the difference between gross margin and selling (or marketing) and administrative expense.

5. Understand the importance of ethical behaviour for management accountants.

- Management accounting aids managers in their efforts to improve the economic performance of the firm.
- Unfortunately, some managers have overemphasized the economic dimension and have engaged in unethical and illegal actions. Many of these actions have relied on the management accounting system to bring about and even support that unethical behaviour.
- To emphasize the importance of the ever present constraint of ethical behaviour, this text presents ethical issues in many of the problems appearing at the end of each chapter.

CORNERSTONES FOR CHAPTER 1

Review Problems

I. Types of Costs, Cost of Goods Manufactured, Absorption-Costing Income Statement

Palmer Manufacturing produces weather vanes. For the year just ended, Palmer produced 10,000 weather vanes with the following total costs:

Direct materials	$20,000
Direct labour	35,000
Overhead	10,000
Selling expenses	6,250
Administrative expenses	14,400

During the year, Palmer sold 9,800 units for $12 each. Beginning finished goods inventory consisted of 630 units with a total cost of $4,095. There were no beginning or ending inventories of work in process.

Required:

1. Calculate the unit costs for the following: direct materials, direct labour, overhead, prime cost, and conversion cost.
2. Prepare schedules for cost of goods manufactured and cost of goods sold.
3. Prepare an absorption-costing income statement for Palmer Manufacturing.

Solution:

1. Unit direct materials = $20,000/10,000 = $2.00
   Unit direct labour = $35,000/10,000 = $3.50
   Unit overhead = $10,000/10,000 = $1.00
   Unit prime cost = $2.00 + $3.50 = $5.50
   Unit conversion cost = $3.50 + $1.00 = $4.50

2. Statement of cost of goods manufactured:

Direct materials used	$20,000
Direct labour	35,000
Overhead	10,000
Total manufacturing costs added	65,000
Add: Beginning work in process	0
Less: Ending work in process	(0)
Cost of goods manufactured	65,000

Cost of goods sold schedule:

Cost of goods manufactured	$65,000
Add: Beginning finished goods inventory	4,095
Less: Ending finished goods inventory*	(5,395)
Cost of goods sold	$63,700

*Units in ending finished goods inventory = 10,000 + 630 − 9,800 = 830; 830 × ($2.00 + $3.50 + $1.00) = $5,395.

3. Income statement:

Sales (9,800 × $12)		$117,600
Less: Cost of goods sold		63,700
Gross margin		53,900
Less: Operating expenses:		
Selling expenses	$ 6,250	
Administrative expenses	14,400	20,650
Operating income		$ 33,250

SERVICE

II. Systems Concepts

Kate Myers is a student at Memorial University. Her system for tracking finances includes the following. Kate has two credit cards; each day she places the receipts for any items purchased on credit in a manila envelope on her desk. She checks these receipts against the credit card bills at the end of the month. Any other financial item that Kate thinks might be useful later is also placed into the envelope. (An example would be a payroll stub from her job as a worker in the campus cafeteria.) Kate records any cheque written in her chequebook register at the time she writes it. Shortly after her bank statement arrives, she enters any cheques written and deposits made into Quicken® (the software program she uses to balance her chequebook). She then reconciles her bank statement against the Quicken account and prints a reconciliation report. From time to time, Kate phones home to ask her mother to add more money to her bank account. (Kate could e-mail or text her mom, but she's found that her mother appreciates the personal touch of a phone call, and the money appears more quickly whenever Kate phones.) Her mother, who has copies of the deposit slips for Kate's account, mails a cheque (from her own account) with a deposit slip to Kate's account. Whenever this occurs, Kate logs on to **Bluemountain.com** and e-mails her mother an electronic thank you card.

The following items are associated with this financial system:

a. Manila envelope
b. Chequebook
c. Cheques and deposit slips
d. Computer and printer
e. Quicken program
f. Credit cards
g. Credit card receipts

h. Payroll stubs, etc.
i. Monthly bank statements
j. Reconciliation report
k. Phone

Required:

1. What are the objectives of Kate's financial system? What processes can you identify?
2. Classify the items into one of the following categories:
   a. Interrelated parts
   b. Inputs
   c. Outputs
3. Draw an operational model for the financial system.

Solution:

1. The objectives of Kate's financial system are to keep her financially solvent and to provide a clear and accurate picture of her chequing account balance and bills incurred at any point in time. Processes include filing the credit card receipts, entering cheques written and deposits made into both the manual and computerized systems, reconciling the bank statement with the computerized system, phoning home for additional funds, and e-mailing a thank you card.
2. The items are classified as follows:
   a. Manila envelope—interrelated part
   b. Chequebook—interrelated part
   c. Cheques and deposit slips—input
   d. Computer and printer—interrelated part
   e. Quicken program—interrelated part
   f. Credit cards—interrelated part
   g. Credit card receipts—input
   h. Payroll stubs, etc.—input
   i. Monthly bank statements—interrelated part
   j. Reconciliation report—output
   k. Phone—interrelated part
3. Operational model of Kate's financial system:

Inputs	Processes	Objectives
Cheques	Filing credit card receipts	Stay financially solvent
Deposit slips	Entering cheques/deposits	Be aware of bills incurred
Credit card receipts	Reconciling statements	Know account balance
Payroll stubs, etc.	Phoning for additional funds	
	E-mailing thank you card	

Key Terms

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Allocation, 11
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Discussion Questions

1. What is an accounting information system?
2. What is the difference between a financial accounting information system and a cost management information system?
3. What are the objectives of a cost management information system?
4. What is a cost object? Give some examples.
5. What is an activity? Give some examples of activities within a manufacturing firm.
6. What is a direct cost? An indirect cost?
7. What does traceability mean?
8. What is allocation?
9. Explain how driver tracing works.
10. What is a tangible product?
11. What is a service? Explain how services differ from tangible products.
12. Identify the three cost elements that determine the cost of making a product (for external reporting).
13. How do the income statements of a manufacturing firm and a service firm differ?

Cornerstone Exercises

OBJECTIVE 3
CORNERSTONE 1-1

Cornerstone Exercise 1-1 PRODUCT COSTS

Sodowsky Manufacturing Inc. produces brightly coloured clog-style shoes. For next year, Sodowsky predicts that 150,000 units will be produced, with the following total costs:

Direct materials	$300,000
Direct labour	90,000
Variable overhead	45,000
Fixed overhead	420,000

Required:

1. Calculate the prime cost per unit.
2. Calculate the conversion cost per unit.
3. Calculate the total variable cost per unit.
4. Calculate the total product (manufacturing) cost per unit.
5. ***What if*** the number of units increased to 165,000 and all unit variable costs stayed the same? Explain what the impact would be on the following costs: total direct materials, total direct labour, total variable overhead, total fixed overhead, unit prime cost, unit conversion cost. What would the product cost per unit be in this case?

Cornerstone Exercise 1-2 COST OF GOODS MANUFACTURED

OBJECTIVE 4
CORNERSTONE 1-2

Refer to **Cornerstone Exercise 1-1**. For next year, Sodowsky predicts that 150,000 units will be produced, with the following total costs:

Direct materials	$300,000
Direct labour	90,000
Variable overhead	45,000
Fixed overhead	420,000

Next year, Sodowsky expects to purchase $292,400 of direct materials. Projected beginning and ending inventories for direct materials and work in process are as follows:

	Direct Materials Inventory	Work-in-Process Inventory
Beginning	$22,400	$45,000
Ending	14,800	40,000

Required:

1. Prepare a statement of cost of goods manufactured in good form.
2. ***What if*** the ending inventory of direct materials increased by $2,000? Which line items on the statement of cost of goods manufactured would be affected and in what direction (increase or decrease)?

Cornerstone Exercise 1-3 COST OF GOODS SOLD

OBJECTIVE 4
CORNERSTONE 1-3

Refer to **Cornerstone Exercises 1-1 and 1-2**.

Sodowsky expects to produce 150,000 units and sell 140,000 units. Beginning inventory of finished goods is $25,000 and ending inventory of finished goods is expected to be $74,000.

Required:

1. Prepare a statement of cost of goods sold in good form.
2. ***What if*** the beginning inventory of finished goods decreased by $5,000? What would be the effect on the cost of goods sold?

Cornerstone Exercise 1-4 INCOME STATEMENT

OBJECTIVE 4
CORNERSTONE 1-4

Refer to **Cornerstone Exercises 1-1, 1-2, and 1-3**. Next year, Sodowsky expects to produce 150,000 units and sell 140,000 units at a price of $7.50 each. Beginning inventory of finished goods is $25,000 and ending inventory of finished goods is expected to be $74,000. Total selling expense is projected at $33,000 and total administrative expense is projected at $145,000.

Required:

1. Prepare an income statement in good form. Be sure to include the percent of sales column.
2. ***What if*** the cost of goods sold percentage for the past few years was 80 percent? Explain how management might react.

OBJECTIVE 3

CORNERSTONE 1-1

SERVICE

Cornerstone Exercise 1-5 COSTS OF SERVICES

Jean and Tom Perritz own and manage Happy Home Helpers Inc. (HHH), a house cleaning service. Each cleaning (cleaning one house one time) takes a team of three house cleaners about 1.5 hours. On average, HHH completes about 15,000 cleanings per year. The following total costs are associated with the total cleanings:

Direct materials	$ 27,000
Direct labour	472,500
Variable overhead	15,000
Fixed overhead	18,000

Required:

1. Calculate the prime cost per cleaning.
2. Calculate the conversion cost per cleaning.
3. Calculate the total variable cost per cleaning.
4. Calculate the total service cost per cleaning.
5. ***What if*** rent on the office that Jean and Tom use to run HHH increased by $1,500? Explain the impact on the following:
   a. Prime cost per cleaning
   b. Conversion cost per cleaning
   c. Total variable cost per cleaning
   d. Total service cost per cleaning

OBJECTIVE 4

CORNERSTONE 1-2

SERVICE

Cornerstone Exercise 1-6 COST OF SERVICES PRODUCED

Jean and Tom Perritz own and manage Happy Home Helpers Inc. (HHH), a house cleaning service. Each cleaning (cleaning one house one time) takes a team of three house cleaners about 1.5 hours. On average, HHH completes about 15,000 cleanings per year. The following total costs are associated with the total cleanings:

Direct materials	$ 27,000
Direct labour	472,500
Variable overhead	15,000
Fixed overhead	18,000

Next year, HHH expects to purchase $25,600 of direct materials. Projected beginning and ending inventories for direct materials are as follows:

	Direct Materials Inventory
Beginning	$4,000
Ending	2,600

There is no work-in-process inventory; in other words, a cleaning is started and completed on the same day.

Required:

1. Prepare a statement of services produced in good form.
2. ***What if*** HHH planned to purchase $30,000 of direct materials? Assume there would be no change in beginning and ending inventories of materials. Explain which line items on the statement of services produced would be affected and how (increase or decrease).

OBJECTIVE 4

CORNERSTONE 1-3

SERVICE

Cornerstone Exercise 1-7 COST OF SERVICES SOLD

Jean and Tom Perritz own and manage Happy Home Helpers Inc. (HHH), a house cleaning service. Each cleaning (cleaning one house one time) takes a team of three

house cleaners about 1.5 hours. On average, HHH completes about 15,000 cleanings per year. The following total costs are associated with the total cleanings:

Direct materials	$ 27,000
Direct labour	472,500
Variable overhead	15,000
Fixed overhead	18,000

Next year, HHH expects to purchase $25,600 of direct materials. Projected beginning and ending inventories for direct materials are as follows:

Direct Materials Inventory	
Beginning	$4,000
Ending	2,600

There is no work-in-process inventory and no finished goods inventory; in other words, a cleaning is started and completed on the same day.

Required:

1. Prepare a statement of cost of services sold in good form.
2. How does this cost of services sold statement differ from the cost of goods sold statement for a manufacturing firm?

Cornerstone Exercise 1-8 INCOME STATEMENT

OBJECTIVE ➤ 4

CORNERSTONE 1-4

Jean and Tom Perritz own and manage Happy Home Helpers Inc. (HHH), a house cleaning service. Each cleaning (cleaning one house one time) takes a team of three house cleaners about 1.5 hours. On average, HHH completes about 15,000 cleanings per year. The following total costs are associated with the total cleanings:

Direct materials	$ 27,000
Direct labour	472,500
Variable overhead	15,000
Fixed overhead	18,000

Next year, HHH expects to purchase $25,600 of direct materials. Projected beginning and ending inventories for direct materials are as follows:

Direct Materials Inventory	
Beginning	$4,000
Ending	2,600

There is no work-in-process inventory and no finished goods inventory; in other words, a cleaning is started and completed on the same day. HHH expects to sell 15,000 cleanings at a price of $45 each next year. Total selling expense is projected at $22,000, and total administrative expense is projected at $53,000.

Required:

1. Prepare an income statement in good form.
2. ***What if*** Jean and Tom increased the price to $50 per cleaning and no other information was affected? Explain which line items in the income statement would be affected and how.

Exercises

Exercise 1-9 SYSTEMS CONCEPTS

OBJECTIVE ➤ 1

SERVICE

In general, systems are described by the following pattern: (1) interrelated parts, (2) processes, and (3) objectives. Operational models of systems also identify inputs and outputs.

The dishwashing system of a university cafeteria consists of the following steps. First, students dispose of any waste paper (e.g., napkins) in a trash can, then they file by an opening to the dishwashing area and drop off their trays. Persons 1 and 2 take the trays; rinse the extra food down the disposal; and stack the dishes, glasses, and silverware in heavy-duty plastic racks. These racks slide along a conveyor into the automatic dishwasher. When the racks emerge from the other end of the dishwasher, they contain clean, germ-free items. Person 3 removes the racks and, with Person 4, empties them of clean items, stacking the dishes, silverware, glasses, and trays for future use. The empty racks are returned to the starting position in front of Persons 1 and 2. The following items are associated with this dishwashing system:

a. Automatic dishwasher
b. Racks to hold the dirty glasses, silverware, and dishes
c. Electricity
d. Water
e. Waste disposal
f. Sinks and sprayers
g. Dish detergent
h. Gas heater to heat water to 85 degrees Celsius
i. Conveyor belt
j. Persons 1, 2, 3, and 4
k. Clean, germ-free dishes
l. Dirty dishes
m. Half-eaten dinner
n. Aprons

Required:

1. What is the objective of the dishwashing system? What processes can you identify?
2. Classify the items into one of the following categories:
   a. Interrelated parts
   b. Inputs
   c. Outputs
3. Draw an operational model for the dishwashing system.
4. Discuss how a cost management information system is similar to and different from the dishwashing system.

OBJECTIVE 1

Exercise 1-10 COST ACCOUNTING INFORMATION SYSTEM

The following items are associated with a cost accounting information system:

a. Usage of direct materials
b. Assignment of direct materials cost to each product
c. Direct labour cost incurrence
d. Depreciation on production equipment
e. Cost accounting personnel
f. Submission of a bid, using product cost plus 25 percent
g. Power cost incurrence
h. Materials handling cost incurrence
i. Computer
j. Assignment of direct labour costs to products
k. Costing out of products
l. Decision to continue making a part rather than buying it
m. Printer
n. Report detailing individual product costs
o. Assignment of overhead costs to individual products

Required:

1. Classify the preceding items into one of the following categories:
   a. Interrelated parts
   b. Processes

c. Objectives
d. Inputs
e. Outputs
f. User actions

2. Draw an operational model that illustrates the cost accounting information system—with the preceding items used as examples for each component of the model.
3. Based on your operational model, identify which product cost definition is being used: value-chain, operating, or product (manufacturing).

Exercise 1-11 COST ASSIGNMENT METHODS

OBJECTIVE ➤ 2

Nizam Company produces speaker cabinets. Recently, Nizam switched from a traditional departmental assembly line system to a manufacturing cell in order to produce the cabinets. Suppose that the cabinet manufacturing cell is the cost object. Assume that all or a portion of the following costs must be assigned to the cell:

a. Depreciation on electric saws, sanders, and drills used to produce the cabinets
b. Power to heat and cool the plant in which the cell is located
c. Salary of cell supervisor
d. Wood used to produce the cabinet housings
e. Maintenance for the cell's equipment (provided by the maintenance department)
f. Labour used to cut the wood and to assemble the cabinets
g. Replacement sanding belts
h. Cost of janitorial services for the plant
i. Ordering costs for materials used in production
j. The salary of the industrial engineer (she spends about 20 percent of her time on work for the cell)
k. Cost of maintaining plant and grounds
l. Cost of plant's personnel office
m. Depreciation on the plant
n. Plant receptionist's salary and benefits

Required:

Identify which cost assignment method would likely be used to assign the costs of each of the preceding activities to the cabinet manufacturing cell: direct tracing, driver tracing, or allocation. When driver tracing is selected, identify a potential activity driver that could be used for the tracing.

Exercise 1-12 PRODUCT COST DEFINITIONS

OBJECTIVE ➤ 3

Three possible product cost definitions were introduced: (1) value-chain, (2) operating, and (3) product or manufacturing. Identify which of the three product cost definitions best fits the following situations (justify your choice):

a. Determining which of several potential new products should be developed, produced, and sold
b. Deciding whether to produce and sell a product whose design and development costs were higher than budgeted
c. Setting the price for a new product
d. Valuation of finished goods inventories for external reporting
e. Determining whether to add a complementary product to the product line
f. Choosing among competing product designs
g. Calculating cost of goods sold for external reporting
h. Deciding whether to increase the price of an existing product
i. Deciding whether to accept or reject a special order, where the price offered is lower than the normal selling price

OBJECTIVE 3 4

Exercise 1-13 COST DEFINITIONS

Labrador Company provided the following information for the past calendar year:

Beginning inventory:	
Direct materials	$56,800
Work in process	34,700
Ending inventory:	
Direct materials	31,000
Work in process	29,700

During the year, direct materials purchases amounted to $160,200, direct labour cost was $225,600, and overhead cost was $308,400. There were 10,000 units produced.

Required:

1. Calculate the total cost of direct materials used in production.
2. Calculate the cost of goods manufactured. Calculate the unit manufacturing cost.
3. Of the unit manufacturing cost calculated in Requirement 2, $18.60 is direct materials and $30.85 is overhead. What is the prime cost per unit? Conversion cost per unit?

OBJECTIVE 3 4

Exercise 1-14 COST DEFINITIONS AND CALCULATIONS

For each of the following independent situations, calculate the missing values:

1. The Avoyelles plant purchased $143,000 of direct materials during June. Beginning direct materials inventory was $9,000, and direct materials used in production were $110,000. What is ending direct materials inventory?
2. Bienville Company produced 8,000 units at an average cost of $11.80 each. The beginning inventory of finished goods was $3,422. (The average unit cost was $11.80.) Bienville sold 8,120 units. How many units remain in ending finished goods inventory?
3. Beginning WIP was $20,000, and ending WIP was $18,750. If total manufacturing costs were $40,000, what was the cost of goods manufactured?
4. If the conversion cost is $84 per unit, the prime cost is $70, and the manufacturing cost per unit is $120, what is the direct materials cost per unit?
5. Total manufacturing costs for August were $446,900. Prime cost was $290,000, and beginning WIP was $160,000. The cost of goods manufactured was $512,000. Calculate the cost of overhead for August and the cost of ending WIP.

OBJECTIVE 4

Exercise 1-15 COST OF GOODS MANUFACTURED AND SOLD

Favourite Brands Company produces condensed soups at its Red Deer plant. At the beginning of June, the following information was supplied by its accountant:

Direct materials inventory	$34,000
Work-in-process inventory	24,500
Finished goods inventory	46,000

During June, direct labour cost was $78,000, direct materials purchases were $346,000, and the total overhead cost was $380,600. The inventories at the end of June were:

Direct materials inventory	$56,000
Work-in-process inventory	37,500
Finished goods inventory	56,000

Required:

1. Prepare a cost of goods manufactured statement for June.
2. Prepare a cost of goods sold schedule for June.

OBJECTIVE 3 4

Exercise 1-16 PRIME COST, CONVERSION COST, PREPARATION OF INCOME STATEMENT: MANUFACTURING FIRM

Roundabout Shoe Company makes walking shoes. During the past calendar year, a total of 90,000 pairs of shoes were made, and 89,000 were sold for $54.00 per pair. The actual unit cost per pair of shoes is as follows:

Direct materials	$13.20
Direct labour	5.80
Variable overhead	3.50
Fixed overhead	16.75
Total unit cost	$39.25

The selling expenses consisted of a commission of $2.70 per pair sold and advertising co-payments totalling $236,000. Administrative expenses, all fixed, equalled $183,000. There were no beginning and ending work-in-process inventories. Beginning finished goods inventory was $235,500 for 6,000 pairs of shoes.

Required:

1. Calculate the number and the dollar value of walking shoes in ending finished goods inventory.
2. Prepare a cost of goods sold statement.
3. Prepare an absorption-costing income statement.

Exercise 1-17 COST OF GOODS MANUFACTURED AND SOLD

OBJECTIVE 4

Lucero Company, a manufacturing firm, has supplied the following information from its accounting records for the past calendar year:

Direct labour cost	$206,780
Purchases of direct materials	160,400
Freight-in on materials	830
Factory supplies used	37,800
Factory utilities	46,000
Commissions paid	47,562
Factory supervision and indirect labour	190,000
Advertising	145,600
Materials handling	26,750
Work-in-process inventory, January 1	201,000
Work-in-process inventory, December 31	98,000
Direct materials inventory, January 1	47,000
Direct materials inventory, December 31	17,000
Finished goods inventory, January 1	18,000
Finished goods inventory, December 31	62,700

Required:

1. Prepare a cost of goods manufactured statement.
2. Prepare a cost of goods sold statement.

Exercise 1-18 INCOME STATEMENT, DIRECT AND INDIRECT COST CONCEPTS, SERVICE COMPANY

OBJECTIVE 3 4

SERVICE

Janine Wellington owns and operates a package mailing store near a university. Her store, Send 'n' Deliver, helps customers wrap items and send them via UPS, FedEx, and Canada Post. Send 'n' Deliver also rents mailboxes to customers by the month. In May, purchases of materials (stamps, cardboard boxes, tape, Styrofoam peanuts, bubble wrap, etc.) equalled $11,450; the beginning inventory of materials was $1,050, and the ending inventory of materials was $950. Payments for direct labour during the month totalled $5,570. Overhead incurred was $8,130 (including rent, utilities, and insurance, as well as payments of $4,050 to UPS and FedEx for the delivery services sold). Since Send 'n' Deliver is a franchise, Janine owes a monthly franchise fee of 5 percent of sales. She spent $750 on advertising during the month. Other administrative costs (including accounting and legal services and a trip to Calgary for training) amounted to $3,650 for the month. Revenues for May were $36,100.

Required:

1. What was the cost of materials used for packaging and mailing services during May?
2. What was the prime cost for May?

3. What was the conversion cost for May?
4. What was the total cost of services for May?
5. Prepare an income statement for May.
6. Of the overhead incurred, is any of it direct? Indirect? Explain.

OBJECTIVE 1

Exercise 1-19 PRODUCT COST DEFINITIONS, VALUE CHAIN

Millennium Pharmaceuticals Inc. (MPI) designs and manufactures a variety of drugs. One new drug, Glaxane, has been in development for seven years. Health Canada approval has just been received, and MPI is ready to begin production and sales.

Required:

Which costs in the value chain would be considered by each of the following managers in their decision regarding Glaxane?

1. Shelly Roberts is plant manager of the New Glasgow, Nova Scotia plant where Glaxane will be produced. Shelly has been assured that Glaxane capsules will use well-understood processes and not require additional training or capital investment.
2. Leslie Bothan is vice president of marketing. Leslie's job involves pricing and selling Glaxane. Because Glaxane is the first drug in its "drug family" to be commercially produced, there is no experience with potential side effects. Extensive testing did not expose any real problems (aside from occasional heartburn and insomnia), but the company cannot be sure that such side effects do not exist.
3. Dante Fiorello is chief of research and development. His charge is to ensure that all research projects, taken as a whole, eventually produce drugs that can support the R&D labs. He is assessing the potential for further work on drugs in the Glaxane family.

OBJECTIVE 3 4

Exercise 1-20 DIRECT MATERIALS COST, PRIME COST, CONVERSION COST, COST OF GOODS MANUFACTURED

Tremblay Company provided the following information for the past calendar year:

Beginning inventory:	
Direct materials	$59,000
Work in process	13,000
Finished goods	34,000
Ending inventory:	
Direct materials	27,500
Work in process	14,500
Finished goods	70,100

During the year, direct materials purchases amounted to $125,000, direct labour cost was $320,000, and overhead cost was $490,000. During the year, 50,000 units were completed.

Required:

1. Calculate the total cost of direct materials used in production.
2. Calculate the cost of goods manufactured. Calculate the unit manufacturing cost.
3. Of the unit manufacturing cost calculated in Requirement 2, $3.20 is direct materials and $9.80 is overhead. What is the prime cost per unit? Conversion cost per unit?

OBJECTIVE 4

Exercise 1-21 COST OF GOODS SOLD, INCOME STATEMENT

Refer to **Exercise 1-20**. Last calendar year, Tremblay recognized revenue of $1,320,000 and had selling and administrative expenses of $204,600.

Required:

1. What is the cost of goods sold for last year?
2. Prepare an income statement for Tremblay for last year.

Problems

Problem 1-22 COST ASSIGNMENT METHODS

OBJECTIVE 3 4

Brody Company makes industrial cleaning solvents. Various chemicals, detergent, and water are mixed together and then bottled in 40-litre drums. Brody provided the following information for last year:

Raw materials purchases	$250,000
Direct labour	140,000
Depreciation on factory equipment	45,000
Depreciation on factory building	30,000
Depreciation on headquarters building	50,000
Factory insurance	15,000
Property taxes:	
Factory	20,000
Headquarters	18,000
Utilities for factory	34,000
Utilities for sales office	1,800
Administrative salaries	150,000
Indirect labour salaries	156,000
Sales office salaries	90,000
Beginning balance, Raw Materials	124,000
Beginning balance, Work in Process	124,000
Beginning balance, Finished Goods	84,000
Ending balance, Raw Materials	102,000
Ending balance, Work in Process	130,000
Ending balance, Finished Goods	82,000

Last year, Brody completed 100,000 units. Sales revenue equalled $1,200,000, and Brody paid a sales commission of 5 percent of sales.

Required:

1. Calculate the direct materials used in production for last year.
2. Calculate total prime cost.
3. Calculate total conversion cost.
4. Prepare a cost of goods manufactured statement for last year. Calculate the unit product cost.
5. Prepare a cost of goods sold statement for last year.
6. Prepare an income statement for last year. Show the percentage of sales that each line item represents.

Problem 1-23 INCOME STATEMENT, COST OF GOODS MANUFACTURED

OBJECTIVE 3 4

Spencer Company produced 200,000 cases of sports drinks during the past calendar year. Each case of 1-litre bottles sells for $36. Spencer had 2,500 cases of sports drinks in finished goods inventory at the beginning of the year. At the end of the year, there were 11,500 cases of sports drinks in finished goods inventory. Spencer's accounting records provide the following information:

Purchases of direct materials	$2,350,000
Direct materials inventory, January 1	290,000
Direct materials inventory, December 31	112,000
Direct labour	1,100,000
Indirect labour	334,000
Depreciation, factory building	525,000
Depreciation, factory equipment	416,000
Property taxes on factory	65,000
Utilities, factory	150,000
Insurance on factory	200,000

(*continued*)

Salary, sales supervisor	$ 85,000
Commissions, salespersons	216,000
Advertising	500,000
General administration	390,000
Work-in-process inventory, January 1	450,000
Work-in-process inventory, December 31	750,000
Finished goods inventory, January 1	107,500
Finished goods inventory, December 31	488,750

Required:

1. Prepare a cost of goods manufactured statement.
2. Compute the cost of producing one case of sports drink last year.
3. Prepare an income statement on an absorption-costing basis. Include a column showing the percent of each line item of sales. (Round your percentage answers to two significant digits, e.g., 45.67%.)

OBJECTIVE 2 4

Problem 1-24 COST OF GOODS MANUFACTURED, COST IDENTIFICATION, SOLVING FOR UNKNOWNS

Skilz-Accountants Company creates, produces, and sells CD-ROM-based CA review courses for individual use. Jeretta Chan, head of human resources, is convinced that question development employees must have strong analytical and problem-solving skills. She has asked Terrell Slater, controller for Skilz-Accountants, to help develop problems for use in screening applicants before they are interviewed. One of the problems Terrell has developed is based on the following data for a mythical company for the previous year:

a. Conversion cost was $240,000 and was three times the prime cost.
b. Direct materials used in production equalled $45,000.
c. Cost of goods manufactured was $295,000.
d. Ending work in process is 20 percent of the cost of beginning work in process.
e. There are no beginning or ending inventories for direct materials.
f. Cost of goods sold was 80 percent of cost of goods manufactured.
g. Beginning finished goods inventory was $14,400.

Required:

1. Using the above information, prepare a cost of goods manufactured statement.
2. Using the above information, prepare a cost of goods sold statement.

OBJECTIVE 3 4

SERVICE

Problem 1-25 INCOME STATEMENT, COST OF SERVICES PROVIDED, SERVICE ATTRIBUTES

Mason, Singh, and Westbrook (MSW) is a tax services firm. The firm is located in Thunder Bay, Ontario, and employs 15 professionals and eight staff. The firm does tax work for small businesses and well-to-do individuals. The following data are provided for the past fiscal year. (The Mason, Singh, and Westbrook fiscal year runs from July 1 through June 30.)

Returns processed	3,000
Returns in process, beginning of year	$ 44,000
Returns in process, end of year	13,000
Cost of services sold	1,557,500
Beginning direct materials inventory	20,000
Purchases, direct materials	40,000
Direct labour	1,400,000
Overhead	100,000
Administrative expenses	257,000
Selling expenses	65,000

Required:

1. Prepare a statement of cost of services sold.
2. Refer to the statement prepared in Requirement 1. What is the dominant cost? Will this always be true of service organizations? If not, provide an example of an exception.
3. Assuming that the average fee for processing a return is $850, prepare an income statement for Mason, Singh, and Westbrook.
4. Discuss three differences between services and tangible products. Calculate the average cost of preparing a tax return for last year. How do the differences between services and tangible products affect the ability of MSW to use the past year's average cost of preparing a tax return in budgeting the cost of tax return services to be offered next year?

Problem 1-26 COST OF GOODS MANUFACTURED, INCOME STATEMENT

OBJECTIVE 3 4

Paulisse Company produces hand lotion for resale by discount chains. For last year, Paulisse reported the following:

Work-in-process inventory, January 1	$ 13,250
Work-in-process inventory, December 31	28,250
Finished goods inventory, January 1	113,000
Finished goods inventory, December 31	85,000
Direct materials inventory, January 1	16,200
Direct materials inventory, December 31	10,700
Direct materials used	170,200
Direct labour	72,000
Plant depreciation	9,500
Salary, production supervisor	45,000
Indirect labour	40,600
Utilities, factory	5,700
Sales commissions	40,000
Salary, sales supervisor	75,000
Depreciation, factory equipment	25,000
Administrative expenses	162,000
Supplies (40% used in the factory, 60% used in the sales office)	8,000

Last year, Paulisse produced 230,000 units and sold 250,000 units at $4 per unit.

Required:

1. Prepare a statement of cost of goods manufactured.
2. Prepare an absorption-costing income statement.

Problem 1-27 ETHICAL ISSUES

OBJECTIVE 5

John Biggs and Patty Jorgenson are both cost accounting managers for a division of a service firm. During lunch yesterday, Patty told John that she was planning on quitting her job in three months because she had accepted a position as controller of a small company in a neighbouring province. The starting date was timed to coincide with the retirement of the current controller. Patty was excited because it allowed her to live near her family. Today, the divisional controller took John to lunch and informed him that he was taking a position at headquarters and that he had recommended that Patty be promoted to his position. He indicated to John that it was a close call between him and Patty and that he wanted to let John know personally about the decision before it was announced officially.

Required:

What should John do? Describe how you would deal with his ethical dilemma (considering the CMA Code of Professional Ethics for management accountants in your response).

OBJECTIVE 5

Problem 1-28 ETHICAL ISSUES

Emily Thibauld, controller of an oil exploration division, has just been approached by Tim Wilson, the divisional manager. Tim told Emily that the projected quarterly profits were unacceptable and that expenses need to be reduced. He suggested that a clean and easy way to reduce expenses would be to assign the exploration and drilling costs of four dry holes to those of two successful holes. The costs could then be capitalized and not expensed, reducing the costs that needed to be recognized for the quarter. He further argued that the treatment would be reasonable because the exploration and drilling all occurred in the same field; thus, the unsuccessful efforts really were the costs of identifying the successful holes. "Besides," he argued, "even if the treatment is wrong, it can be corrected in the annual financial statements. Next quarter's revenues will be more and can absorb any reversal without causing any severe damage to that quarter's profits. It's this quarter's profits that need some help."

Emily is uncomfortable with the request because generally accepted accounting principles do not sanction the type of accounting measures proposed by Tim.

Required:

1. Using the CMA Code of Professional Ethics for management accountants, recommend the approach that Emily should take.
2. Suppose Tim insists that his suggested accounting treatment be implemented. What should Emily do?

CMA Problems

OBJECTIVE 5

SERVICE

CMA Problem 1-1 ETHICAL ISSUES*

Silverado Inc. is a closely held brokerage firm that has been very successful over the past five years, consistently providing most members of the top management group with 50 percent bonuses. In addition, both the chief financial officer and the chief executive officer have received 100 percent bonuses. Silverado expects this trend to continue.

Recently, the top management group of Silverado, which holds 40 percent of the outstanding shares of common stock, has learned that a major corporation is interested in acquiring Silverado. Silverado's management is concerned that this corporation may make an attractive offer to the other shareholders and that management would be unable to prevent the takeover. If the acquisition occurs, this executive group is uncertain about continued employment in the new corporate structure. As a consequence, the management group is considering changes to several accounting policies and practices that, although not in accordance with generally accepted accounting principles, would make the company a less attractive acquisition. Management has told Larry Stewart, Silverado's controller, to implement some of these changes. Stewart has also been informed that Silverado's management does not intend to disclose these changes at once to anyone outside the immediate top management group.

Required:

Using the CMA Code of Professional Ethics for management accountants, evaluate the changes that Silverado's management is considering, and discuss the specific steps that Larry Stewart should take to resolve the situation. *(CMA adapted)*

OBJECTIVE 5

CMA Problem 1-2 ETHICAL ISSUES*

Emery Manufacturing Company produces component parts for the farm equipment industry and has recently undergone a major computer system conversion. Jake Murray, the controller, has established a troubleshooting team to alleviate accounting problems that have occurred since the conversion. Jake has chosen Gus Swanson, assistant controller, to head the team, which will include Linda Wheeler, cost accountant; Cindy Madsen,

financial analyst; Randy Leung, general accounting supervisor; and Max Crandall, financial accountant.

The team has been meeting weekly for the past month. Gus insists on being part of all the team conversations in order to gather information, to make the final decision on any ideas or actions that the team develops, and to prepare a weekly report for Jake. He has also used this team as a forum to discuss issues and disputes about him and other members of Emery's top management team. At last week's meeting, Gus told the team that he thought a competitor might purchase the common stock of Emery, because he had overheard Jake talking about this on the telephone. As a result, most of Emery's employees now informally discuss the sale of Emery's common stock and how it will affect their jobs.

Required:

Is Gus Swanson's discussion with the team about the prospective sale of Emery unethical? Discuss, citing specific standards from the CMA Code of Professional Ethics for management accountants to support your position. *(CMA adapted)*

CMA Problem 1-3 ETHICAL ISSUES*

OBJECTIVE 5

SERVICE

The external auditors for Heart Health Procedures (HHP) are currently performing the annual audit of HHP's financial statements. As part of the audit, the external auditors have prepared a representation letter to be signed by HHP's chief executive officer (CEO) and chief financial officer (CFO). The letter provides, among other items, a representation that appropriate provisions have been made for:

> *Reductions of any excess or obsolete inventories to net realizable values, and Losses from any purchase commitments for inventory quantities in excess of requirements or at prices in excess of market.*

HHP began operations by developing a unique balloon process to open obstructed arteries to the heart. In the past several years, HHP's market share has grown significantly because its major competitor was forced by Health Canada to cease its balloon operations. HHP purchases the balloon's primary and most expensive component from a sole supplier. Two years ago, HHP entered into a five-year contract with this supplier at the then current price, with inflation escalators built into each of the five years. The long-term contract was deemed necessary to ensure adequate supplies and discourage new competition. However, during the past year, HHP's major competitor developed a technically superior product, which utilizes an innovative, less costly component. This new product was recently approved by Health Canada and has been introduced to the medical community, receiving high acceptance. It is expected that HHP's market share, which has already seen softness, will experience a large decline and that the primary component used in the HHP balloon will decrease in price as a result of the competitor's use of its recently developed superior, cheaper component. The new component has been licensed by the major competitor to several outside supply sources to maintain available quantity and price competitiveness. At this time, HHP is investigating the purchase of this new component.

HHP's officers are on a bonus plan that is tied to overall corporate profits. Jim Honig, vice president of manufacturing, is responsible for both manufacturing and warehousing. During the course of the audit, he advised the CEO and CFO that he was not aware of any obsolete inventory nor any inventory or purchase commitments where current or expected prices were significantly below acquisition or commitment prices. Jim took this position even though Marian Nevins, assistant controller, had apprised him of both the existing excess inventory attributable to the declining market share and the significant loss associated with the remaining years of the five-year purchase commitment.

Marian has brought this situation to the attention of her superior, the controller, who also participates in the bonus plan and who reports directly to the CFO. Marian worked closely with the external audit staff and subsequently ascertained that the

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external audit manager was unaware of the inventory and purchase commitment problems. Marian is concerned about the situation and is not sure how to handle the matter.

Required:

1. Assuming that the controller did not apprise the CEO and CFO of the situation, explain the ethical considerations of the controller's apparent lack of action by discussing specific provisions of the CMA Code of Professional Ethics for management accountants.
2. Assuming Marian Nevins believes the controller has acted unethically and not apprised the CEO and CFO of the findings, describe the steps that she should take to resolve the situation. Refer to the CMA Code of Professional Ethics for management accountants in your answer.
3. Describe actions that HHP can take to improve the ethical situation within the company. *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at ***www.hansen1ce.nelson.com****.*

After studying this chapter, you should be able to:

1. Define and describe fixed, variable, and mixed costs.
2. Explain the use of resources and activities and their relationship to cost behaviour.
3. Separate mixed costs into their fixed and variable components using the high-low method, the scatterplot method, and the method of least squares.
4. Evaluate the reliability of the cost formula.
5. Discuss the use of managerial judgment in determining cost behaviour.
6. Explain how multiple regression can be used to assess cost behaviour.
7. Define the learning curve, and discuss its impact on cost behaviour.

CHAPTER 2

Cost Behaviour

Costs can display variable, fixed, or mixed behaviour. Knowing how costs change as activity changes is essential to planning, controlling, and decision making. For example, budgeting, deciding to keep or drop a product line, and evaluating the performance of a segment all depend on an understanding of cost behaviour. Not knowing and understanding cost behaviour can lead to poor—and even disastrous—decisions. This chapter discusses cost behaviour in depth so that a proper foundation is laid for its use in studying other cost management topics. Cost-volume-profit analysis (Chapter 3) and variable-costing systems (Chapter 12), for example, require that all costs be classified as fixed or variable. This chapter describes ways of separating costs into fixed and variable categories, discusses the assumptions and limitations underlying these methods, and assesses the reliability of these procedures.

OBJECTIVE 1
Define and describe fixed, variable, and mixed costs.

Basics of Cost Behaviour

Cost behaviour is the term used to describe whether a cost changes when the level of output changes. A cost that does not change as output changes is a *fixed cost*. A *variable cost*, on the other hand, increases in total with an increase in output and decreases in total with a decrease in output. While economics may *assume* that fixed and variable costs are known, in the real world, management accountants must determine them. Let's first review the basics of cost behaviour. Then, we will look at fixed, variable, and mixed costs. Finally, we will assess the impact of time horizon on cost behaviour.

Cost Objects

Recall from Chapter 1 that a cost object is the item for which managers want cost information. So the first step is to determine appropriate cost objects. This is relatively easy in a manufacturing firm; the cost object is typically the tangible product. For service firms, the logical cost object is the service. For example, hospitals may view particular services such as blood tests or radiology services as primary cost objects. There are, however, a variety of cost objects for which managers may need to know cost behaviour.

The Internet has fundamentally changed the way companies do business with their suppliers and customers. Price competition is severe so firms cannot, typically, succeed using a low-price strategy. Instead, they use a customer-service strategy. Internet-based companies strive to provide a shopping experience that is user friendly, with an abundance of information tailored to customer needs and a secure payment system. Ideally, the company provides a seamless interface for customers, taking them from information search, through product/service choice, payment, and post-sale follow-up. Software that tracks ongoing customer preferences is a large part of the enhanced customer shopping experience. **Amazon.com** is an excellent example of this, as it welcomes new and returning customers and makes the shopping experience fun and easy. As a result, "Internet-based firms rely much less on traditional infrastructure assets, such as buildings, and more on speakers, specialized software, and intellectual capital that cater to customers in cyberspace." This means that the customer is the appropriate cost object, and activities and drivers that are tied to customer service are important data to Internet-based firms.[1]

Activity Drivers and Measures of Output

The terms *fixed cost* and *variable cost* only have meaning when related to some output measure or driver. Therefore, we must first determine the underlying activities and the associated drivers that measure the output of an activity. For example, materials handling may be measured by the number of moves; shipping goods may be measured by the units sold; and laundering hospital linen may be measured by the kilograms of laundry. The choice of driver is tailored not only to the particular firm but also to the particular activity or cost being measured.

Activity drivers explain changes in activity costs by measuring changes in activity output (usage). The two general categories of activity drivers are *unit-level drivers* and *non-unit-level drivers*. Recall that drivers are factors that *cause* changes in resource usage, activity usage, costs, and revenues. **Unit-level drivers** explain changes in cost as units produced change. Kilograms of direct materials, kilowatt-hours used to run production machinery, and direct labour hours are examples of unit-based activity drivers. Each of these drivers varies proportionately with the number of units produced. **Non-unit-level drivers** explain how costs change as factors other than the number of units produced change. Examples of non-unit-based output measures

[1] Taken from Lawrence A. Gordon and Martin P. Loeb, "Distinguishing Between Direct and Indirect Costs Is Crucial for Internet Companies," *Management Accounting Quarterly* II, no. 4 (Summer 2001): 12–17.

include the number of setups, work orders, engineering change orders, inspection hours, and material moves.

In a traditional cost management system, cost behaviour is assumed to be described by unit-based drivers only. In an activity-based cost management system, both unit- and non-unit-based drivers are used. Thus, the ABC system tends to produce a much richer view of cost behaviour than would a traditional, unit-based, system. As a result, under the ABC system, cost behaviour patterns for a much broader set of activities must now be identified.

We now take a closer look at fixed, variable, and mixed costs.

Fixed Costs

Fixed costs are costs that *in total* are constant within the relevant range as the level of the activity driver varies. To illustrate fixed cost behaviour, consider a plant operated by Echo Audio Systems Inc. that produces speakers for home audio systems. One department in the plant produces a 9-centimetre voice coil and inserts it into each speaker passing through the department. The activity is voice-coil production, and the activity driver is the number of voice coils produced. The department operates two production lines, and each can make up to 100,000 voice coils per year. The production workers of each line are supervised by a production-line manager who is paid $60,000 per year. For production up to 100,000 units, only one manager is needed; for production between 100,001 and 200,000 units, the second line is activated and two managers are needed. The cost of supervision for several levels of production for the plant is given as follows:

Echo Audio Systems Inc.

Supervision Cost	Voice Coils Produced	Unit Cost
$ 60,000	40,000	$1.50
60,000	80,000	0.75
60,000	100,000	0.60
120,000	120,000	1.00
120,000	160,000	0.75
120,000	200,000	0.60

The first step in assessing cost behaviour is defining an appropriate activity driver. In this case, the activity driver is the number of voice coils produced. The second step is defining what is meant by **relevant range**, the range over which the assumed cost relationship is valid for the normal operations of a firm. Suppose that the relevant range is 120,000 to 200,000 speakers processed. Notice that the *total* cost of supervision remains constant within this range as more voice coils are produced. Echo Audio Systems pays $120,000 for supervision regardless of whether it produces 120,000, 160,000, or 200,000 voice coils.

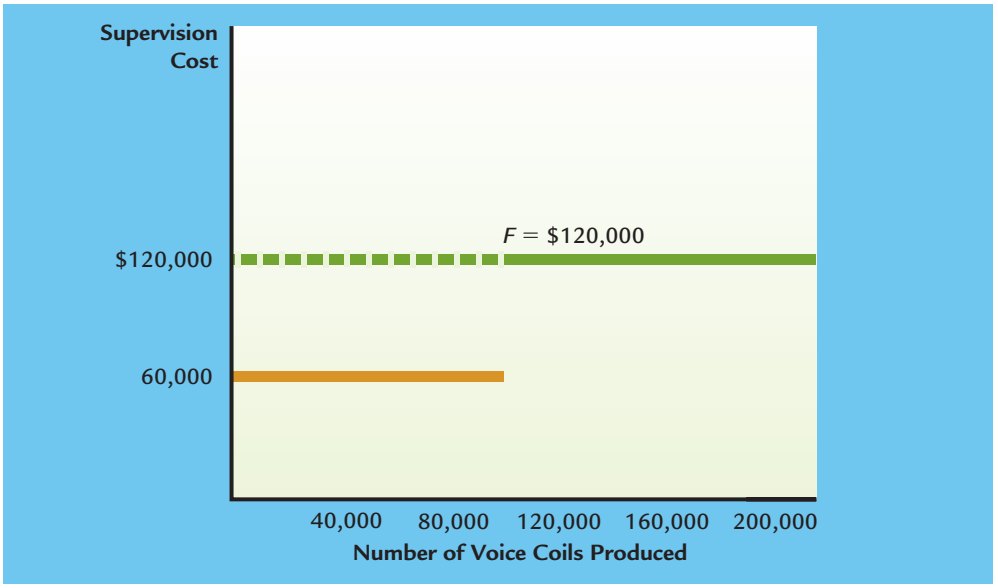
Pay particular attention to the words *in total* in the definition of fixed costs. While the total cost of supervision remains unchanged as more voice coils are produced, the unit cost does change as the level of the activity driver changes. As the example shows, within the relevant range, the unit cost of supervision decreases from $1.00 to $0.60. Because of the behaviour of per-unit fixed costs, it is easy to get the impression that fixed costs are affected by changes in the level of the activity driver, when in reality they are not. Unit fixed costs can be misleading and may adversely affect some decisions. It is often safer to work with total fixed costs.

Exhibit 2-1 is a graph of fixed cost behaviour. For the relevant range, fixed cost behaviour is described by a horizontal line. Notice that for 120,000 voice coils produced, supervision cost is $120,000; for 160,000 voice coils produced, supervision cost is still $120,000. This line visually demonstrates that cost remains unchanged as the level of the activity driver varies. For the relevant range, total fixed costs can be represented by the following simple linear equation:

$$F = \text{Total fixed costs}$$

Exhibit 2-1

Fixed Cost Behaviour



In the example for Echo Audio Systems, supervision cost amounted to $120,000 for any level of output between 100,001 and 200,000 voice coils produced. Thus, supervision is a fixed cost, and the fixed cost equation in this case is $F = \$120{,}000$. Strictly speaking, this equation assumes that the fixed costs are $120,000 for all levels (as if the line extends to the vertical axis as indicated by the dashed portion in Exhibit 2-1). Although this assumption is not true, it is harmless as long as the operating decisions are confined to the relevant range.

Can fixed costs change? Of course they can, but this does not make them variable. They are fixed at a new higher (or lower) level. Suppose that Echo Audio Systems gives a raise to the voice coil line supervisors. Instead of being paid $60,000 per year, they are paid $64,000 per year. Now the cost of supervision is $128,000 per year ($2 \times \$64{,}000$). However, supervisory costs are still fixed with respect to the number of voice coils produced. Can you draw in the new fixed cost line on Exhibit 2-1?[2]

Variable Costs

Variable costs are defined as costs that, in total, vary in direct proportion to changes in an activity driver. To illustrate, let's expand the Echo Audio Systems example to examine the direct materials cost of the voice coils. The cost is the cost of direct materials for the voice coils, and the activity driver is the number of voice coils produced. Each voice coil requires direct materials costing $3. The total direct materials cost of voice coils for various levels of production is given as follows:

Echo Audio Systems Inc.

Total Direct Materials Cost of Voice Coils	Voice Coils Produced	Unit Direct Materials Cost of Voice Coils
$120,000	40,000	$3
240,000	80,000	3
360,000	120,000	3
480,000	160,000	3
600,000	200,000	3

[2] The new line is a horizontal line that intersects the y-axis at $128,000. Note that it is drawn parallel to and above the original fixed cost line.

As more voice coils are produced, the total cost of direct materials increases in direct proportion. For example, as production doubles from 80,000 to 160,000 units, the *total* cost of voice coils doubles from $240,000 to $480,000. Notice also that the unit cost of voice coils is constant.

Variable costs can also be represented by a linear equation. Here, total variable costs depend on the level of activity driver. This relationship can be described by the following equation:

$$Y_v = VX$$

where

Y_v = Total variable costs
V = Variable cost per unit
X = Number of units of the driver

The relationship describing the cost of direct materials is $Y_v = \$3X$, where $X =$ the number of voice coils produced. Exhibit 2-2 shows graphically that variable cost behaviour is represented by a straight line coming from the origin. At zero units processed, total variable cost is zero. However, as units produced increase, the total variable cost also increases. Note that total variable cost increases in direct proportion to increases in the number of voice coils produced (the activity driver); the rate of increase is measured by the slope of the line. At 120,000 voice coils produced, the total variable cost of direct materials is $360,000 ($3 × 120,000); at 160,000 voice coils produced, the total variable cost is $480,000 ($3 × 160,000).

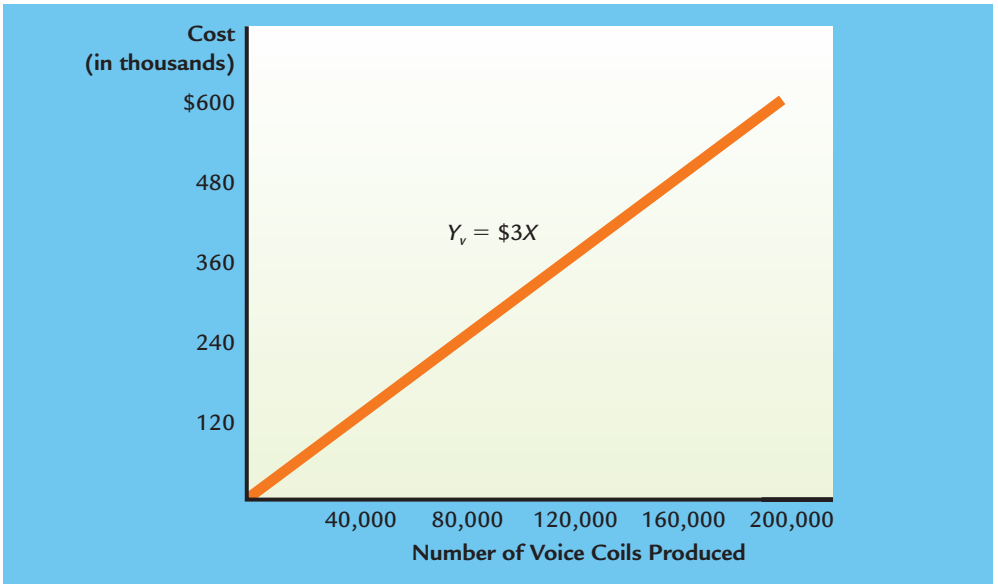
Linearity Assumption

The definition of variable costs just given and the graph in Exhibit 2-2 imply a linear relationship between the cost of direct materials and the number of voice coils produced. How reasonable is the assumption that costs are linear? Do costs really increase in direct proportion to increases in the level of the activity driver? If not, then how well does this assumed linear cost function approximate the underlying cost function?

Economists usually assume that variable costs increase at a decreasing rate up to a certain volume, at which point they increase at an increasing rate. This type of

Exhibit 2-2

Variable Cost Behaviour



nonlinear behaviour is displayed in Exhibit 2-3. Here, variable costs increase as the number of units increases, but not in direct proportion.

If the nonlinear view more accurately portrays reality, what should we do? One possibility is to determine the actual cost function—but every activity could have a different cost function, and this approach could be very time consuming and expensive (if it can even be done). It is much simpler to assume a linear relationship.

If the linear relationship is assumed, then the main concern is how well this assumption approximates the underlying cost function. Exhibit 2-4 gives us some idea of the consequences of assuming a linear cost function. As with fixed costs, we can define the *relevant range* as the range of activity for which the assumed cost

Exhibit 2-3

Nonlinearity of Variable Costs

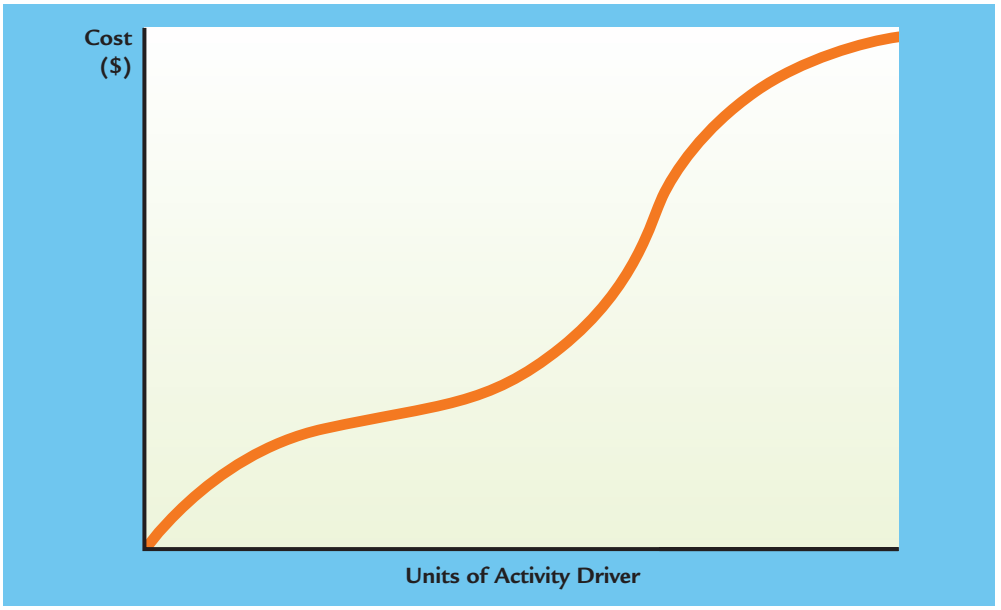
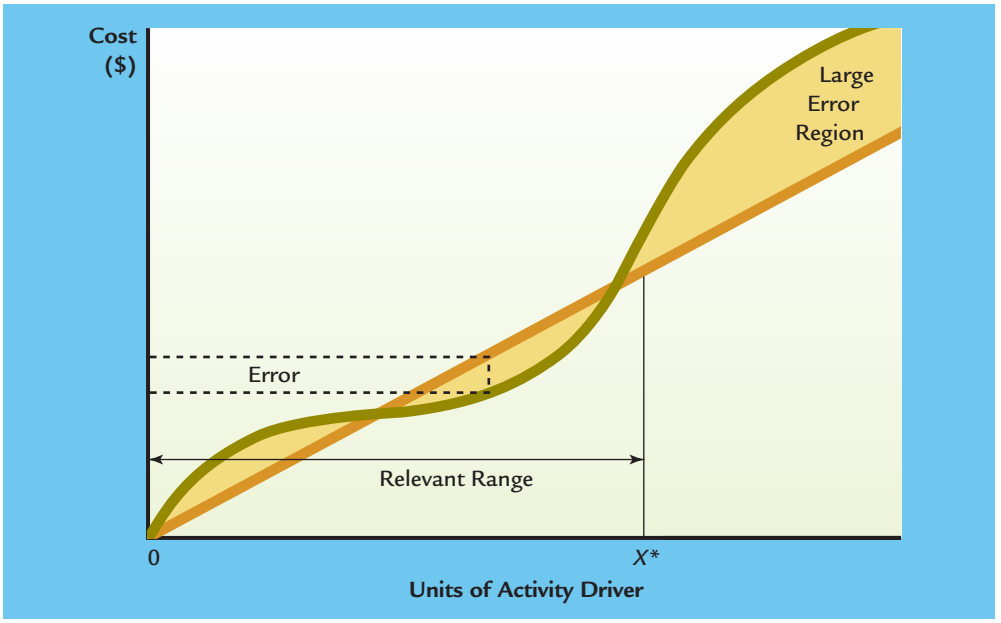


Exhibit 2-4

Relevant Range for Variable Costs



The HOW and WHY of Forming an Equation to Describe Mixed Cost

CORNERSTONE 2-1

Information:

Echo Audio Systems has 10 sales representatives, each earning a salary of $30,000 per year plus a commission of $5 per speaker sold. Last year, 100,000 speakers were sold.

Why:

As long as 100,000 speakers is in the relevant range, then a straight line depicts the cost relationship well. If the cost function is known, sensitivity analysis can be used to see what the total selling cost would be at differing levels of sales.

Required:

1. Develop a cost equation for total selling cost.
2. Compute the total variable selling cost last year.
3. Compute the total selling cost last year.
4. Compute the unit selling cost for last year.
5. ***What if*** 110,000 speakers had been sold last year? What would be the total selling cost and the unit selling cost? Explain why the unit selling cost decreased.

Solution:

1. Total selling cost = Fixed selling cost + (Variable rate × Units sold)
   = $300,000 + ($5 × Units sold)
2. Total variable selling cost = Variable rate × Units sold
   = $5 × 100,000
   = $500,000
3. Total selling cost = $300,000 + ($5 × Units sold)
   = $300,000 + $500,000
   = $800,000
4. Unit selling cost = Total selling cost/Units sold
   = $800,000/100,000
   = $8
5. Total selling cost = $300,000 + ($5 × 110,000) = $850,000
   Unit selling cost = $850,000/110,000 = $7.73 (rounded)

   The unit selling cost went down because the fixed cost, which stays the same, is spread out over a greater number of units.

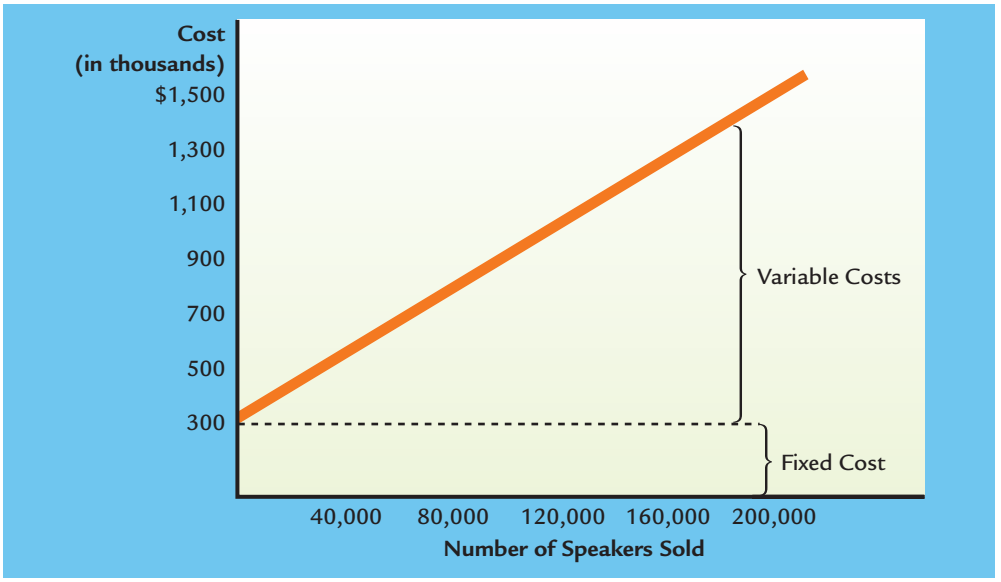
relationships are valid. Here, validity refers to how closely the linear cost function approximates the underlying cost function. Note that for units of the activity driver beyond X^*, the approximation appears to break down.

Mixed Costs

Mixed costs are costs that have both a fixed and a variable component. For example, sales representatives are often paid a salary plus a commission on sales. Suppose that Echo Audio Systems has 10 sales representatives, each earning a salary of $30,000 per year plus a commission of $5 per speaker sold. The activity is selling, and the activity driver is units sold. If 100,000 speakers are sold, then the total selling cost (associated with the sales representatives) is $800,000—the sum of the fixed salary cost of $300,000 (10 × $30,000) and the variable cost of $500,000 ($5 × 100,000). Cornerstone 2-1 shows how and why the linear equation can be used to describe a mixed cost.

Exhibit 2-5

Mixed Cost Behaviour



The graph for our mixed cost example is given in Exhibit 2-5. (The graph assumes that the relevant range is 0 to 200,000 units.) Mixed costs are represented by a line that intercepts the vertical axis (at $300,000, for this example). The intercept corresponds to the fixed cost component, and the slope of the line gives the variable cost per unit of activity driver (slope is $5 for the example portrayed).

Time Horizon

Determining whether a cost is fixed or variable depends on the time horizon. According to economics, in the **long run**, all costs are variable; in the **short run**, at least one cost is fixed. But how long is the short run? Different costs have short runs of different lengths. Direct materials, for example, are relatively easy to adjust. **Tim Hortons** may treat coffee beans (a direct material) as strictly variable, even though for the next few hours the amount already on hand is fixed. The lease of space for one of its coffee shops, however, is more difficult to adjust; it may run for one or more years. This cost is typically seen as fixed. The length of the short-run period depends to some extent on management judgment and the purpose for which cost behaviour is being estimated. For example, submitting a bid on a one-time, special order may span only a month—long enough to create a bid and produce the order. Other types of decisions, such as product mix decisions, will affect costs over a much longer period of time. In this case, the costs that must be considered are long-run variable costs, including product design, product development, market development, and market penetration. Short-run costs often do not adequately reflect all the costs necessary to design, produce, market, distribute, and support a product. Recently, there have been some insights that help shed light on the nature of long- and short-run cost behaviours.[3] These insights relate to activities and the resources needed to enable an activity to be performed.

OBJECTIVE 2

Explain the use of resources and activities and their relationship to cost behaviour.

Resources, Capacity and Cost Behaviour

Resources are economic elements that enable one to perform activities. Common resources of a manufacturing plant include direct materials, direct labour, electricity,

[3] For more on these concepts, see the following. Robert S. Kaplan and Robin Cooper, *Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance*, 9th ed. (Cambridge, MA: Harvard Business Press, 1998); and Alfred M. King, "The Current Status of Activity-Based Costing: An Interview with Robin Cooper and Robert S. Kaplan," *Management Accounting* (September 1991): 22–26.

equipment, and so on. When a company spends money on resources, it is *acquiring* the ability or capacity to perform an activity.

Activity is a task, such as setting up equipment, purchasing materials, assembling materials, and packing completed units in boxes. When a firm acquires the resources needed to perform an activity, it obtains **activity capacity**. Usually, the amount of activity capacity needed corresponds to the level where the activity is performed efficiently. This efficient level of activity performance is called **practical capacity**.

If all of the activity capacity acquired is not used, then there is **unused capacity**, which is the difference between the acquired capacity and the actual amount of the activity used. The relationship between resource spending and resource usage can be used to define variable and fixed cost behaviour.

Flexible Resources

Resources can be categorized as (1) flexible and (2) committed. **Flexible resources** are supplied as used and needed. The organization is free to buy what it needs, when it needs it, so the quantity of the resource supplied equals the quantity demanded. There is no unused capacity for this category of resources (resources used equal resources supplied).

Since the cost of flexible resources equals the cost of resources used, the total cost of the resource increases as demand for the resource increases. The cost of a flexible resource is a variable cost. For example, in a just-in-time manufacturing environment, materials are purchased when needed and are used right away. Thus, as the units produced increase, the amount (and cost) of direct materials increases proportionately. Similarly, power is a flexible resource. Using kilowatt-hours as the driver, as the demand for power increases, the cost of power increases. Note that in each example, resource supply and usage is measured by an output measure, or driver.

Committed Resources

Committed resources are supplied in advance of usage. An explicit or implicit contract is used to obtain a given quantity of resource, regardless of whether that amount is fully used or not. Because the amount of committed resource supplied may exceed the firm's demand for it, unused capacity is possible.

Many resources are acquired before the actual demands for the resource are realized. There are two examples of this category of resource acquisition. First, organizations acquire *multi-period service capacities* by paying cash up front or by entering into an explicit contract that requires periodic cash payments. Buying or leasing buildings and equipment are examples of this form of advance resource acquisition. The annual expense associated with the multi-period category is independent of actual usage of the resource. Often, these expenses are referred to as **committed fixed expenses**. They essentially correspond to committed resources—costs incurred that provide long-term activity capacity.

Discretionary Fixed Resources Some organizations acquire resources in advance through implicit contracts—usually with their employees. These implicit contracts require an ethical focus, since they imply that the organization will maintain employment and salary levels even though there may be temporary downturns in the quantity of activity used. Hiring three engineers for $150,000 who can supply the capacity of processing 7,500 change orders (the driver) is an example of implicit contracting. Often, in response to customer feedback and competitive pressures, products need to be redesigned or modified. An engineering change order is the document that initiates this process. Certainly, none of the three engineers would expect to be laid off if only 5,000 change orders were actually processed—unless, of course, the downturn in demand is viewed as being permanent.

Companies can manage economic ups and downs with lower-level salaries and then vary the level of bonuses at the end of the year. In addition, many companies use a lower level of permanent employees and a fluctuating level of temporary, or contingent, workers. This is a growing trend that includes both manufacturing and

service industries as well as unskilled (e.g., day labourers) and skilled workers (e.g., nurses and information technology specialists).[4]

Google has had a policy of using temporary staff. By early 2009, the company was rumoured to have asked as many as 10,000 temporary workers to leave. This tactic was taken in response to declining growth in the amount of Internet advertising as the falling economy led many other companies to cut their advertising budgets.[5]

A key reason for the use of contingent workers is flexibility—in meeting demand fluctuations, in controlling downsizing, and in buffering core workers against job loss.[6] Resource spending for this category essentially corresponds to **discretionary fixed expenses**—costs incurred for the acquisition of short-term activity capacity.

Resource Usage Implications for Control and Decision Making

The resource usage model just described can improve both managerial control and decision making. Operational control information systems encourage managers to pay more attention to controlling resource usage and spending. A well-designed operational system would allow managers to assess the changes in resource demands that will occur from new product mix decisions. Adding new, customized products may increase the demand for various overhead activities; if sufficient unused activity capacity does not exist, then resource spending must increase.

Similarly, if resource usage can be reduced, bringing about unused capacity, managers must carefully consider what to do with the excess capacity. Eliminating the excess capacity may decrease resource spending and thus improve overall profits. Alternatively, using the excess capacity to increase output could increase revenues without a corresponding increase in resource spending.

The activity-based resource usage model also allows managers to better calculate the changes in resource supply and demand resulting from decisions such as make or buy, accept or reject special orders, and keep or drop product lines. The model increases the power of a number of traditional management accounting decision-making models. These are explored in the decision-making Chapters 15 to 17, and in Chapter 18 (online at www.hansen1ce.nelson.com).

Step-Cost Behaviour

So far, we have assumed that the cost function is continuous. In reality, some cost functions may be discontinuous. One such discontinuous function, a step function, is shown in Exhibit 2-6. A **step-cost function** displays a constant level of cost for a range of output and then jumps to a higher level of cost at some point, where it remains for a similar range of activity. In Exhibit 2-6, the cost is $100, as long as output is between 0 and 20 units. If the volume is between 20 and 40 units, the cost jumps to $200.

Step-Variable Costs

Items that display a step-cost behaviour must be purchased in chunks. The width of the step defines the range of activity output for which a particular quantity of the resource must be acquired. The width of the step in Exhibit 2-6 is 20 units of activity. If the width of the step is narrow, as in Exhibit 2-6, the cost of the resource changes in response to fairly small changes in resource usage (as measured by activity output). Costs that follow a step-cost behaviour with narrow steps are defined as **step-variable costs**. If the width of the step is narrow, step-variable costs can be approximated by a strictly variable cost.

Step-Fixed Costs

In reality, many so-called fixed costs may be best described by a step-cost function. Many committed resources—particularly those that involve implicit contracting—follow a step-cost function. Suppose, for example, that a company hires three engineers who are responsible for redesigning existing products to meet

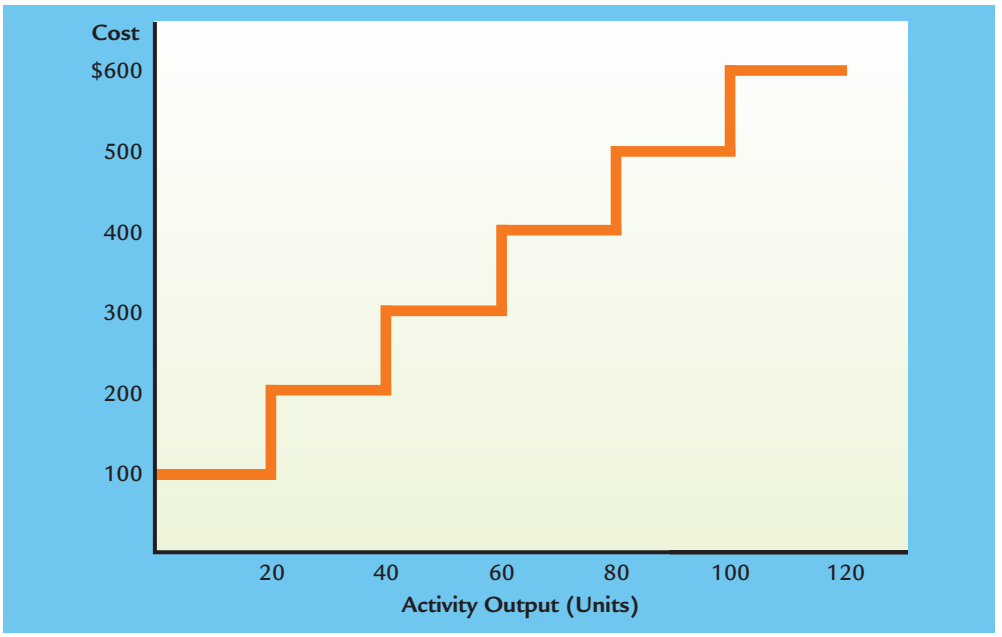
[4] Yukako Ono, "Why Do Firms Use Temporary Workers?" *Chicago Fed Letter*, no. 260 (March 2009).

[5] Nick Farrell, "Google Cuts Staff: Doing Evil after Christmas," *The Inquirer*, January 8, 2009, http://www.theinquirer.net/inquirer/news/1050285/google-cuts-staff. (Accessed May 23, 2009.)

[6] "Contingent Employment on the Rise," *Deloitte & Touche Review* (September 4, 1995): 1–2.

Exhibit 2-6

Step-Cost Function

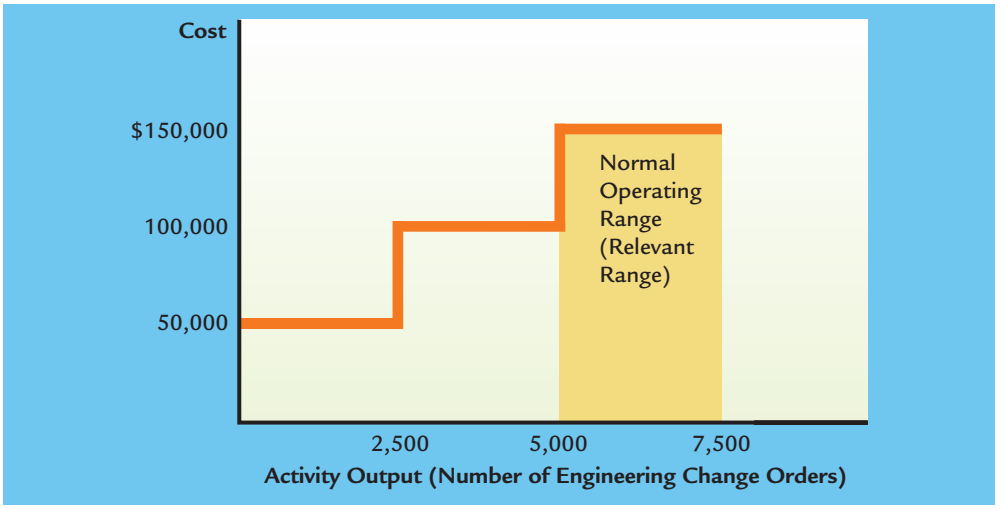


customer requirements. By hiring the engineers, the company has acquired the ability to perform an activity: engineering redesign. The salaries paid to the engineers represent the cost of acquiring the engineering redesign capacity. The number of engineering changes that can be *efficiently* processed by the three engineers is a measure of that capacity. The nature of this resource requires that the capacity be acquired in chunks (one engineer hired at a time). The cost function for this example is displayed in Exhibit 2-7. Notice that the width of the steps is 2,500 units, a much wider step than the cost function displayed in Exhibit 2-6. Costs that follow a step-cost behaviour with wide steps are defined as **step-fixed costs**. Step-fixed costs are assigned to the fixed cost category, since most are fixed over the firm's normal operating range.

When resources are acquired in advance, there may be a difference between the *resources supplied* and the *resources used (demanded)* to perform activities. This can only occur for costs that display fixed cost behaviour (resources acquired in advance

Exhibit 2-7

Step-Fixed Costs



CORNERSTONE 2-2

The HOW and WHY of Calculating Activity Availability, Capacity Used, and Unused Capacity

Information:

Davin Company has three engineers, each of whom is paid $50,000 per year and is able to process 2,500 change orders. Last year, 6,000 change orders were processed by the three engineers.

Why:

If managers know the total capacity available as well as the capacity used, they can better utilize the activity capacity and know when additional capacity must be acquired.

Required:

1. Calculate the activity rate per change order.
2. Calculate, in terms of change orders, the:
   a. total activity availability
   b. unused capacity
3. Calculate, in dollars, the:
   a. total activity availability
   b. unused capacity
4. Express total activity availability in terms of activity capacity used and unused capacity.
5. ***What if*** the number of change orders processed equalled 7,500? What would unused capacity be?

Solution:

1. Activity rate = Total cost of engineers/Number of change orders
   $= (3 \times \$50{,}000)/(3 \times 2{,}500)$
   $= \$20$/change order
2. a. Total activity availability $= 3 \times 2{,}500 = 7{,}500$ change orders
   b. Unused capacity $= 7{,}500 - 6{,}000 = 1{,}500$ change orders
3. a. Total activity availability $= \$20(3 \times 2{,}500) = \$150{,}000$
   b. Unused capacity $= \$20(7{,}500 - 6{,}000) = \$30{,}000$
4. Total activity availability = Activity capacity used + Unused capacity
   $7{,}500 = 6{,}000 + 1{,}500$
   or
   $\$150{,}000 = \$120{,}000 + \$30{,}000$
5. If the actual change orders processed equalled 7,500, then all three engineers would be working at capacity and there would be no unused capacity.

of usage). The traditional cost management system provides information only about the cost of the resources supplied. A contemporary cost management system, on the other hand, tells how much of the activity is used and the cost of its usage, based on the activity rate. The average unit cost, obtained by dividing the resource expenditure by the activity's practical capacity, is the **activity rate**. The activity rate is used to calculate the cost of resource usage and the cost of unused activity. The relationship between resources supplied and resources used is expressed by either of the following two equations:

$$\text{Activity availability} = \text{Activity used (output)} + \text{Unused capacity} \quad (3.1)$$

$$\text{Cost of available activity} = \text{Cost of activity used (output)} + \text{Cost of unused activity} \quad (3.2)$$

Cornerstone 2-2 illustrates the way a company may determine the cost of capacity used and unused capacity.

Notice that the cost of unused capacity shown in Cornerstone 2-2 occurs because the resource (engineering redesign) must be acquired in lumpy (whole) amounts. Even if the company had anticipated the need for only 6,000 change orders, it would have been difficult to hire the equivalent of 2.4 engineers (6,000/2,500).

When activities use a mix of resources that are acquired in advance and resources that are acquired as needed, they display mixed cost behaviour. Suppose that a plant has its own Power Department; it has acquired long-term capacity for supplying power by investing in a building and equipment (resources acquired in advance). The plant also acquires fuel to produce power as needed (resources acquired as needed). The cost of the building and equipment is independent of the kilowatt-hours produced, but the cost of fuel increases as the demand for kilowatt-hours increases. The activity of supplying power has both a fixed cost component and a variable cost component, using kilowatt-hours as the output measure.

Judgment-Based Methods for Separating Mixed Costs

Sometimes it is easy to identify the variable and fixed components of a mixed cost, as in the example in Cornerstone 2-1 for the sales representatives. Many times, however, the only information available is the total cost of an activity and a measure of output (the variables Y and X). For example, the accounting system will usually record both the total cost of the maintenance activity for a given period and the number of maintenance hours provided during that period. The accounting records do not reveal the fixed and variable components of total maintenance cost.

Need for Cost Separation Since accounting records typically show only the total cost and the associated output of a mixed cost item, it is necessary to separate the total cost into its fixed and variable components. Only through a formal effort to separate costs can they be classified into the appropriate cost behaviour categories.

Quantitative Methods for Separating Mixed Costs

OBJECTIVE 3
Separate mixed costs into their fixed and variable components using the high-low method, the scatterplot method, and the method of least squares.

The three widely used quantitative methods of separating a mixed cost into its fixed and variable components are the high-low method, the scatterplot method, and the method of least squares. Each method requires us to make the simplifying assumption of a linear cost relationship. Therefore, before we examine each of these methods more closely, let's review the expression of cost as an equation for a straight line from Cornerstone 2-1.

$$Y = F + VX$$

where

Y= Total cost (the dependent variable)
F= Fixed cost component (the intercept parameter)
V= Variable cost per unit (the slope parameter)
X= Measure of output (the independent variable)

The **dependent variable** is a variable whose value depends on the value of another variable. In the preceding equation, total activity cost is the dependent variable; it is the cost we are trying to predict. The **independent variable** is a variable that measures output and explains changes in the activity cost. It is an activity driver. A good independent variable causes or is closely associated with the dependent variable. The **intercept parameter** corresponds to fixed cost. Graphically, the intercept parameter is the point at which the mixed cost line intercepts the cost (vertical) axis. The **slope parameter** corresponds to the variable cost per unit of activity. Graphically, this represents the slope of the mixed cost line.

Since the accounting records reveal only X and Y, those values must be used to estimate the parameters F and V. With estimates of F and V, the fixed and variable

components can be estimated, and the behaviour of the mixed cost can be predicted as output changes.

Three methods will be described for estimating *F* and *V*: the high-low method, the scatterplot method, and the method of least squares. The same data will be used with each method so that comparisons among them can be made. In the example, the plant manager for Anderson Company wants to determine the fixed and variable components of materials handling costs. He believes that the number of material moves is a good driver for the activity. Data for 10 months of materials handling costs and number of material moves are given in Cornerstone 2-3.

The High-Low Method

Basic geometry tells us that two points determine a line. *F*, the fixed cost component, is the intercept of the total cost line, and *V*, the variable cost per unit, is the slope of the line. Given two points, the slope and the intercept can be determined. The **high-low method** preselects the two points that are used to compute the parameters *F* and *V*. The *high point* is defined as the point with the *highest activity level*. The *low point* is defined as the point with the *lowest activity level*. Note that the high and low points are determined by the independent variable, not the dependent (typically cost) variable. Cornerstone 2-3 shows how and why the high-low method can be used to determine the fixed cost and variable rate.

Notice that the last requirement of Cornerstone 2-3 asks us to compute the materials handling cost for the year, not for a month. Since monthly data were used to determine the cost formula, fixed cost must be multiplied by 12 to get the fixed cost for the year instead of the month. If the materials handling cost for the quarter were desired, then fixed cost would be multiplied by three (the number of months in a quarter). If weekly data had been used to determine the cost formula, the fixed cost for the year would be the weekly fixed cost multiplied by 52, the number of weeks in a year.

The high-low method has two advantages. First, it is objective. That is, any two people using the high-low method on a particular data set will arrive at the same answer. Second, it is simple to calculate. The high-low method allows a manager to get a quick fix on a cost relationship using only two data points. For example, a manager may have only two years of data. Sometimes, this will be enough to get a crude approximation of the cost relationship.

The high-low method is usually not as good as the other methods for two reasons. First, the high and low points can be what are known as outliers. They may represent atypical cost-activity relationships. If so, the cost formula computed using these two points will not represent what usually takes place. The **scatterplot method** can help a manager avoid this trap by selecting two points that appear to be representative of the general cost-activity pattern. Second, even if these points are not outliers, other pairs of points may clearly be more representative. Again, the scatterplot method allows the choice of the more representative points.

An important point must be made regarding the estimates of fixed and variable costs yielded by the high-low method. These estimates should "look reasonable" to the cost analyst. For example, suppose that the high-low method returns a negative fixed cost estimate. That cannot be right; a negative fixed cost implies that a zero amount of the driver would result in revenue to the company. This is another reason that the scatterplot method can be useful. Perhaps the high or the low point is an outlier, such that the line drawn through it is very different from a line that would be drawn if the outlier were thrown out and the second-highest (or lowest) point were selected.

Scatterplot Method

The first step in applying the scatterplot method is to plot the data points so that the relationship between materials handling costs and activity output can be seen. This plot is referred to as a **scattergraph** and is shown in Exhibit 2-8, Graph A. The

The HOW and WHY of Using the High-Low Method to Determine Fixed Cost and Variable Rate

CORNERSTONE 2-3

Information:

Anderson Company had the following 10 months of data on materials handling cost and number of moves:

Month	Materials Handling Cost	Number of Moves
January	$2,000	100
February	3,090	125
March	2,780	175
April	1,990	200
May	7,500	500
June	5,300	300
July	4,300	250
August	6,300	400
September	5,600	475
October	6,240	425

Why:

The high-low method gives managers a quick way of estimating cost behaviour. Only two data points are needed, the high and low activity points, so this method is especially easy for companies without a long history.

Required:

1. Determine the high point and the low point.
2. Calculate the variable rate for materials handling based on the number of moves.
3. Calculate the fixed monthly cost of materials handling.
4. Write the cost formula for the materials handling activity showing the fixed cost and the variable rate.
5. If Anderson Company estimates that November will have 350 moves, what is the total estimated materials handling cost for that month?
6. ***What if*** Anderson wants to estimate materials handling cost for the coming year and expects 3,940 moves? What will estimated total materials handling cost be? What is the total fixed materials handling cost? Why doesn't it equal the fixed cost calculated in Requirement 3 above?

Solution:

1. The high number of moves is in May, and the low number of moves in January. (*Hint:* Did you notice that the low cost of $1,990 was for April, yet April is not the low point because its number of moves is not the lowest activity level?)

2. $$\text{Variable rate} = (\text{High cost} - \text{Low cost})/(\text{High moves} - \text{Low moves})$$
$$= (\$7{,}500 - \$2{,}000)/(500 - 100) = \$5{,}500/400$$
$$= \$13.75 \text{ per move}$$

3. $$\text{Fixed cost} = \text{Total cost} - (\text{Variable rate} \times \text{Moves})$$
Let's choose the high point with cost of $7,500 and 500 moves.
$$\text{Fixed cost} = \$7{,}500 - (\$13.75 \times 500)$$
$$= \$625$$
(*Hint:* Check your work by computing fixed cost using the low point.)

CORNERSTONE 2-3 *(continued)*

4. If the variable rate is $13.75 per move and fixed cost is $625 per month, then the formula for monthly materials handling cost is: Total materials handling cost = $625 + ($13.75 × Moves)
5. Materials handling cost = $625 + $13.75(350) = $5,437.50
6. Materials handling cost for the year = 12($625) + $13.75(3,940)
   = $7,500 + $54,175 = $61,675

   The fixed cost for the year is 12 times the fixed cost for the month. Thus, instead of $625, the yearly fixed cost is $7,500.

vertical axis is total activity cost (materials handling cost), and the horizontal axis is the driver or output measure (number of moves). Looking at Exhibit 2-8, Graph A, we see that the relationship between materials handling costs and number of moves is reasonably linear; cost goes up as the number of moves goes up, and vice versa.

Now let's examine Exhibit 2-8, Graph B, to see if the line determined by the high and low points is representative of the overall relationship. It does look relatively representative. Does that mean that the high-low line should be chosen? Not necessarily. Suppose that management believes the variable costs of materials handling will go down in the near future. In that case, the high-low line gives a somewhat higher variable cost (slope) than desired. The scatterplot line will be chosen with a shallower slope.

Thus, one purpose of a scattergraph is to assess the validity of the assumed linear relationship. Additionally, inspecting the scattergraph may reveal several points that do not seem to fit the general pattern of behaviour. Upon investigation, it may be discovered that these points (the outliers) were due to some irregular occurrences. This knowledge can provide justification for their elimination and perhaps lead to a better estimate of the underlying cost function.

A scattergraph can provide insight concerning the relationship between cost and output by allowing one to visually fit a line to the points on the scattergraph. In doing so, the line should appear to best fit the points. In making that choice, a cost analyst is free to use past experience with the behaviour of the cost item. Experience may provide the analyst with a good intuitive sense of how materials handling costs behave; the scattergraph then becomes a useful tool to quantify this intuition. Fitting a line to the points in this way is how the scatterplot method works. Keep in mind that the scattergraph and the other statistical aids are tools that help managers improve their judgment. Using the tools does not prevent the manager from using his or her own judgment to alter any of the estimates produced by formal methods.

Examine Exhibit 2-8, Graph A, carefully. Based only on the information contained in the graph, how would you fit a line to the points in it? Of course, there are an infinite number of lines that might go through the data, but let's choose one that goes through the point for January (100, $2,000) and intersects the y-axis at $800. Now, we have the straight line shown in Exhibit 2-8, Graph C. The fixed cost is the intercept, $800. The high-low method can be used to determine the variable rate.

The two chosen points are (100, $2,000) and (0, $800). These two points are used to compute the slope:

$$\begin{aligned} V &= (Y_2 - Y_1)/(X_2 - X_1) \\ &= (\$2{,}000 - \$800)/(100 - 0) \\ &= \$1{,}200/100 \\ &= \$12 \end{aligned}$$

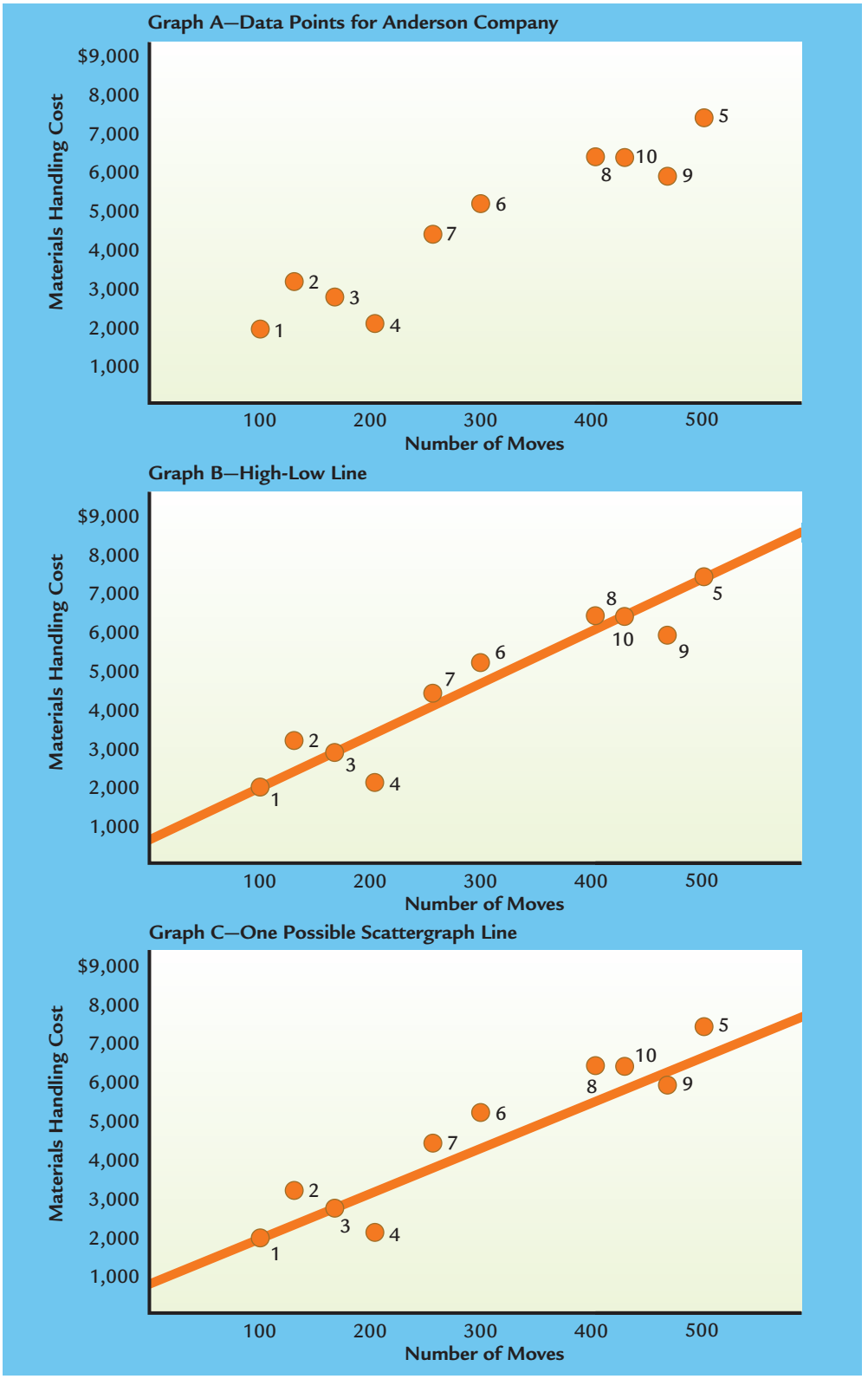
Thus, the variable cost per material move is $12.

The fixed and variable components of the materials handling cost have now been identified. The cost formula for the materials handling activity can be expressed as:

$$Y = \$800 + \$12X$$

Exhibit 2-8

Scattergraph for Anderson Company's Materials Handling Costs



Using this formula, the total cost of materials handling for moves between 100 and 500 can be predicted and then broken down into fixed and variable components. Assume that 350 moves are planned for November. Using the cost formula, the

predicted cost is \$5,000 [\$800 + (\$12 × 350)]. Of this total cost, \$800 is fixed, and \$4,200 is variable.

A significant advantage of the scatterplot method is that it allows a cost analyst to inspect the data visually. The cost formula for materials handling was obtained by fitting a line to two points [(0, \$800) and (100, \$2,000)] in Exhibit 2-8, Graph C. We used our judgment to select the line. Whereas one person may decide that the best-fitting line is the one passing through those two points, others, using their own judgment, may decide that the best line passes through other pairs of points.

The scatterplot method suffers from the lack of any objective criterion for choosing the best-fitting line. The quality of the cost formula depends on the quality of the subjective judgment of the analyst. The high-low method removes the subjectivity in the choice of the line. Regardless of who uses the method, the same line will result.

Looking again at Exhibit 2-8, Graphs B and C, we can compare the results of the scatterplot method with those of the high-low method. There is a difference between the fixed cost components and the variable rates. The predicted materials handling cost for 350 moves is \$5,000 according to the scatterplot method and \$5,437.50 according to the high-low method. Which is "correct"? Since the two methods can produce significantly different cost formulas, the question of which method is the best naturally arises. Ideally, a method that is objective and, at the same time, produces the best-fitting line is needed. The **method of least squares** defines *best-fitting* and is objective in the sense that using the method for a given set of data will produce the same cost formula.

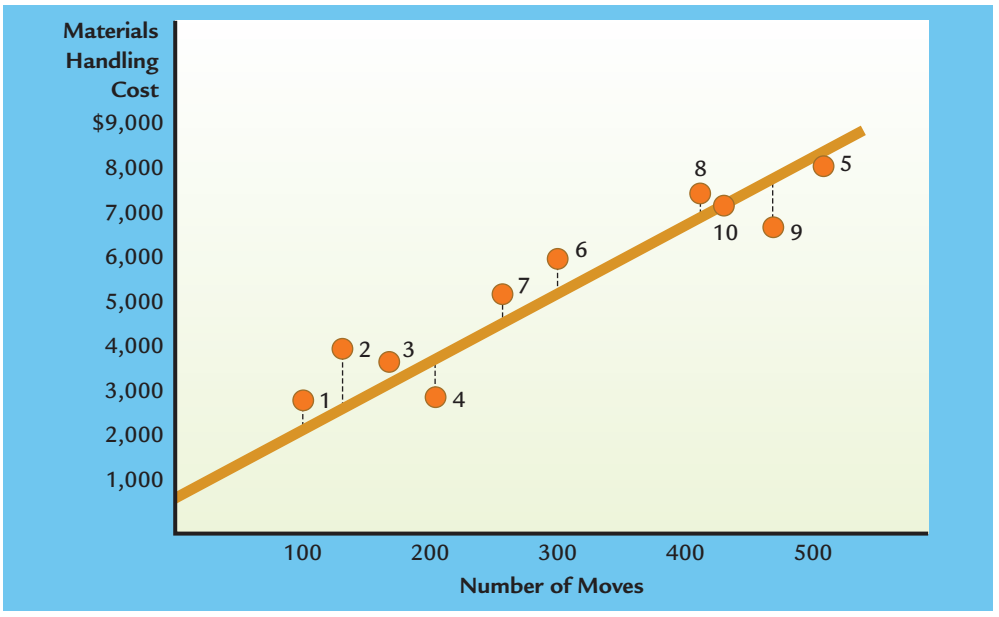
The Method of Least Squares

Up to this point, we have alluded to the concept of a line that best fits the points shown on a scattergraph. What is meant by a best-fitting line? Intuitively, it is the line to which the data points are closest. But what is meant by closest?

Consider Exhibit 2-9. Here, an arbitrary line ($Y = F + VX$) has been drawn. The closeness of each point to the line can be measured by the vertical distance of the point from the line. This vertical distance is the difference between the actual cost and the cost predicted by the line. For point 8, this is $E_8 = Y_8 - (F + VX_8)$, where Y_8 is the actual cost, $F + VX_8$ is the predicted cost, and the deviation is represented by E_8. The **deviation** is the difference between the predicted and actual costs, which is shown by the distance from the point to the line.

Exhibit 2-9

Deviations of Data from a Line



The vertical distance measures the closeness of a single point to the line, but we really need a measure of closeness of *all* points to the line. One possibility is to add all the single measures to obtain an overall measure. However, since the single measures can be positive or negative, this overall measure may not be very meaningful. For example, the sum of small positive deviations could result in an overall measure greater in magnitude than the sum of large positive deviations and large negative deviations because of the cancelling effect of positive and negative numbers. To correct this problem, each single measure of closeness is first squared, and then these squared deviations are summed as the overall measure of closeness. Squaring the deviations avoids the cancellation problem caused by a mix of positive and negative numbers.

To illustrate this concept, a measure of closeness will be calculated for the cost formula produced by the scatterplot method for Anderson Company's materials handling costs.

Actual Cost	Predicted Cost[a]	Deviation[b]	Deviation Squared
$2,000	$2,000	0	0
3,090	2,300	790	624,100
2,780	2,900	−120	14,400
1,990	3,200	−1,210	1,464,100
7,500	6,800	700	490,000
5,300	4,400	900	810,000
4,300	3,800	500	250,000
6,300	5,600	700	490,000
5,600	6,500	−900	810,000
6,240	5,900	340	115,600
Total measure of closeness			5,068,200

[a] Predicted cost = $800 + $12*X*, where *X* is the actual measure of activity output associated with the actual activity cost and cost is rounded to the nearest dollar.
[b] Deviation = Actual cost − Predicted cost.

Since the measure of closeness is the sum of the squared deviations of the points from the line, the smaller the measure, the better the line fits the points. For example, the scatterplot method line has a closeness measure of 5,068,200. A similar calculation produces a closeness measure of 5,402,013 for the high-low line. Thus, the scatterplot line fits the points better than the high-low line. This outcome supports the earlier claim that the use of judgment in the scatterplot method is superior to the high-low method.

In principle, comparing closeness measures can produce a ranking of all lines from best to worst. The line that fits the points better than any other line is called the *best-fitting line*. It is the line with the smallest (least) sum of squared deviations. The method of least squares identifies the best-fitting line. We rely on statistical theory to obtain the formulas that produce the best-fitting line.

Using Regression Programs

Computing the regression formula manually is tedious, even with only a few data points. As the number of data points increases, manual computation becomes impractical. (When multiple regression is used, manual computation is virtually impossible.) Fortunately, spreadsheet packages such as Microsoft Excel® have regression routines that will perform the computations.[7] All you need to do is input the data. The spreadsheet regression program supplies more than the estimates of the coefficients. It also provides information that can be used to see how reliable the cost equation is, a feature that is not available for the scatterplot and high-low methods.

The first step in using the computer to calculate regression coefficients is to enter the data. The next step is to run the regression. In Excel, the regression routine is located under the "Tools" menu (toward the top left of the screen). When you pull down the "Tools" menu, you will see a number of menu possibilities. If you see "Data Analysis" just click on that and then click on "Regression." (If you don't see "Data Analysis," then choose

[7] Excel is a registered trademark of Microsoft Corporation. Any further reference to Excel refers to this footnote.

CORNERSTONE 2-4

The HOW and WHY of Using the Regression Results for Fixed Cost and Variable Rate to Construct and Use a Cost Formula

Information:

Anderson Company had 10 months of data on materials handling cost and number of moves, as shown in Cornerstone 2-3. Regression was run on these data and the coefficients shown by the regression program results are:

Intercept	854.4994
X variable 1	12.39153

Why:

Regression gives the best linear unbiased estimates of the intercept and slope for a set of data points. These can be used to find the fixed cost and variable rate in a cost scenario, and can be used to predict cost for a given amount of the independent variable.

Required:

1. Construct the cost formula for the materials handling activity showing the fixed cost and the variable rate.
2. If Anderson Company estimates that November will have 350 moves, what is the total estimated materials handling cost for that month?
3. ***What if*** Anderson wants to estimate materials handling cost for the coming year and expects 3,940 moves? What will estimated total materials handling cost be? What is the total fixed materials handling cost? Why doesn't it equal the fixed cost calculated in Requirement 2 above?

Solution:

1. Rounding the regression estimates to the nearest cent, the formula for monthly materials handling cost is:

$$\text{Total materials handling cost} = \$854.50 + (\$12.39 \times \text{Moves})$$

2. Materials handling cost $= \$854.50 + \$12.39(350) = \$5{,}191$
3. Materials handling cost for the year $= 12(\$854.50) + \$12.39(3{,}940)$
$= \$10{,}254 + \$48{,}816.60 = \$59{,}070.60$

   The fixed cost for the year is 12 times the fixed cost for the month. Thus, instead of $854.50, the yearly fixed cost is $10,254.

"Add-Ins" and then select "Analysis ToolPak." This will add the data analysis tools. When the data analysis tools have been added, "Data Analysis" will appear at the bottom of the "Tools" menu; click on "Data Analysis," and then "Regression.")

When the "Regression" screen pops up, you can tell the program where the dependent and independent variables are located. In the box labelled "Input Y Range," place the cursor at the beginning of the rectangle, click, and then (again using the cursor) block the values under the dependent variable column. Then, move the cursor to the beginning of the box for the "Input X Range," click, and block the values in the appropriate cells. Finally, you need to tell the computer where to place the output. You can choose to put it on a separate worksheet or on the current worksheet. Let's assume you are going to save the output to the current worksheet. Click on the radio button by your choice, and then, using your cursor, block a nice-sized rectangle and click on "OK." In less than the blink of an eye, the regression output is complete.

Cornerstone 2-4 takes the results of the regression program and uses them to construct a cost formula. That cost formula can then be used to determine the predicted cost given an estimate of the independent variable.

Since the regression cost formula is the best-fitting line, it should produce better predictions of materials handling costs than either the high-low or scatterplot methods. From Cornerstone 2-4 for 350 moves, the estimate predicted by the least-squares line is \$5,191 [\$854.50 + (\$12.39 × 350)], with a fixed component of \$854.50 plus a variable component of \$4,336.50. Using this prediction as a standard, the scatterplot line most closely approximates the least-squares line.

While computer output can give us the fixed and variable cost coefficients, its major usefulness lies in its ability to provide information about the reliability of the estimated cost formula.

Reliability of Cost Formulas

OBJECTIVE ➤ 4
Evaluate the reliability of the cost formula.

Regression routines provide information to help assess the reliability of the estimated cost formula. This is a feature not provided by either the scatterplot or high-low methods. There are three assessments of the cost formula's reliability: *hypothesis test of cost parameters*, *goodness of fit*, and *confidence intervals*. The **hypothesis test of cost parameters** indicates whether the parameters are different from zero. For our setting, **goodness of fit** measures the degree of association between cost and activity output. This measure is important because the method of least squares identifies the best-fitting line, but it does not reveal how good the fit is. The best-fitting line may not be a good-fitting line. It may perform miserably when it comes to predicting costs. A **confidence interval** provides a range of values for the actual cost with a prespecified degree of confidence. Confidence intervals allow managers to predict a range of values instead of a single prediction. Of course, if the degree of association is perfect, then the confidence interval will consist of a single point and the actual cost will always coincide with the predicted cost. Thus, goodness of fit and confidence intervals are related, and they provide cost analysts some idea of how reliable the resulting cost equation is.

R^2 Coefficient of Variation and Coefficient of Correlation

The coefficient of variation also known as coefficient of determination R^2 explains the percentage of variability of the dependent variable by an independent variable. For example, the materials handling cost (dependent variable) is explained by the number of material moves (independent variable). The higher the percentage of variability of materials handling cost, the better a job the independent variable (number of moves) does in explaining the dependent variable (materials handling costs).

The R^2 always varies from 0 to 1.00. If R^2 is, say, .75, it means that 75 percent of the variability in the materials handling cost is explained by the number of material moves. The rest is due to other variables, which often are unexplained. Depending on one's tolerance for error, the 75 percent may or may not be good enough. There is not an absolute cut-off point for good or bad coefficient of variation. In general, though, the closer the R^2 is to 1, the more acceptable the coefficient of variation. If an R^2 of 75 percent is considered low, one can seek another independent variable that better explains the variation in materials handling costs. For example, materials handling hours may produce, say, a .90 R^2, which clearly better explains the materials handling cost behaviour. Increasing the number of observations of the independent variable (number of material moves) makes the R^2 more reliable. That is why regression analysis takes into account the number of observations of independent variables and is adjusted accordingly.

An alternative measure to coefficient of determination is the coefficient of correlation, which is the square root of R^2. Since square roots can be negative, the value of the coefficient of correlation fluctuates between −1 and +1. If the coefficient of correlation is positive, it means there is a positive relationship between the dependent and independent variable—that is, both move in the same direction: if one increases, so does the other; as the number of materials handling moves increases, so do the

material handling costs. If the correlation coefficient is negative, it suggests there is an inverse relationship between the dependent and independent variable, so that when one increases, the other decreases, and vice versa. The closer the correlation coefficient is to zero, the lower the correlation. A zero correlation coefficient value suggests no correlation between the dependent and independent variable whatsoever.

The regression analysis can be used to predict costs (materials handling cost) at different levels of activity (number of materials handling moves, materials handling labour hours). The predicted costs often differ from the actual costs. The difference is due to the fact that we use only one independent variable, whereas more variables may be shaping up the materials handling costs. Also, the difference may be caused by the inadequacy of the sample of observations, which may not be very reflective of reality.

The size of the difference between predicted and actual results is measured by the prediction standard error. The standard error measures the confidence level around the predicted cost. By adding and subtracting the standard error to predicted cost (PC +/− SE), we create a range of possible values. The width of the range diminishes the value of the coefficient of determination. A narrow width is needed for the prediction to be of good value. To reduce the range, we could use a larger sample, which may decrease the standard error. Using *t* statistics, a degree of confidence—that is, the likelihood that the prediction range will contain the actual cost—can be specified. A 95 percent degree of confidence means that 95 times out of 100 the actual cost will be within the prediction range.

OBJECTIVE 5

Discuss the use of managerial judgment in determining cost behaviour.

Methods of Determining Cost Behaviour

In practice, companies use a variety of methods of estimating costs. Among these are two judgment-based methods—the industrial engineering method and the account analysis method—as well as a variety of quantitative statistical methods. The best cost estimators are individuals who thoroughly understand the process, the cost drivers, and the degree of variability between the driver, the activity, and the cost.

The **industrial engineering method** is a forward-looking method of determining, through physical observation and analysis, just what activities, in what amounts, are needed to complete a process. Time and motion studies may be used in conjunction with this method. Industrial engineers may literally stand behind production workers with a stop watch to determine precisely how many minutes it takes to produce a unit of product. Once completed, the engineering studies are very precise. However, they are expensive to implement and seldom updated once they are done. This method is most frequently used for manufacturing processes where there is a direct link between materials and labour inputs with the output. An advantage of engineering methods is that they can be applied to new processes and designs. Industrial engineers determine the amount of each direct material needed and the amount of labour time each process will take. Then accountants and purchasing specialists can apply the appropriate unit costs. While this method is useful in determining the cost of manufactured items, where the process stays the same from unit to unit, it is less useful in services where different customers or circumstances may require varying amounts of time and types of service.

The **account analysis method** can be used to estimate costs by classifying accounts in the general ledger as fixed, variable, or mixed. In practice, accounts are usually put into either the fixed or variable category based on the predominant nature of the costs in the individual account. This method is often used in practice because it is simple and straightforward to apply. Accountants with a good knowledge of the cost behaviour of the various accounts can create credible cost functions using the approach. As an alternative, some accountants have set up subaccounts in the chart of accounts that are designed to separate relatively fixed from relatively variable cost categories. If costs in each account are predominantly of one of the two types, this method will give reasonable results.

To use the account analysis method, the accountant uses judgment and experience to separate the accounts into two categories—fixed and variable. Once the fixed

categories are known, the average monthly cost can be computed and this is the fixed amount. The variable categories need to be further separated into categories according to the driver the accountant wishes to associate with the account. For example, accounts that are variable with respect to direct labour hours can be separated, their average costs determined, and then that total divided by the average amount of direct labour hours to obtain the variable rate per direct labour hour. Similarly, accounts driven by machine hours, purchase orders, and so on, can be averaged and then divided by their average amount of driver to obtain the rates. Cornerstone 2-5 shows how the account analysis method can be used to separate fixed and variable costs, determine a cost function, and use that cost function in budgeting.

The industrial engineering method and the account analysis method are judgment-based methods of determining cost behaviour. Quantitative methods also exist that rely on past data to generate a linear model that describes the variable and fixed portions of a cost (see Objective 3 in this chapter).

Managerial Judgment

Managerial judgment is critically important in determining cost behaviour and is by far the most widely used method in practice. Many managers simply use their experience and past observation of cost relationships to determine fixed and variable costs. This method, however, may take a number of forms. Some managers simply assign particular activity costs to the fixed category and others to the variable category. They ignore the possibility of mixed costs. Thus, a chemical firm may regard materials and utilities as strictly variable, with respect to kilograms of chemical produced, and all other costs as fixed. Even labour, the textbook example of a unit-based variable cost, may be fixed for this firm. The appeal of this method is simplicity. Before opting for this course of action, management would do well to make sure that each cost is predominantly fixed or variable and that the decisions being made are not highly sensitive to errors in classifying costs as fixed or variable.

To illustrate the use of judgment in assessing cost behaviour, consider **Elgin Sweeper Company**, a leading manufacturer of motorized street sweepers. Using production volume as the measure of activity output, Elgin revised its chart of accounts to organize costs into fixed and variable components. Elgin's accountants used their knowledge of the company to assign expenses to either a fixed or variable category, using a decision rule that categorized an expense as fixed if it were fixed 75 percent of the time and as variable if it were variable 75 percent of the time.[8]

Management may instead identify mixed costs and divide these costs into fixed and variable components by deciding just what the fixed and variable parts are—that is, using experience to say that a certain amount of a cost is fixed and therefore that the rest must be variable. Then, the variable component can be computed using one or more cost/volume data points. This use of judgment has the advantage of accounting for mixed costs but is subject to a similar type of error as the strict fixed/variable dichotomy. That is, management may be wrong in its assessment.

Management may use experience and judgment to refine statistical estimation results. Perhaps the experienced manager might "eyeball" the data and throw out several points as being highly unusual, or the manager might revise results of estimation to take into account projected changes in cost structure or technology. For example, **Tecnol Medical Products Inc.** radically changed its method of manufacturing medical face masks. Traditionally, face mask production was very labour intensive, requiring hand stitching. Tecnol developed its own highly automated equipment and became the industry's low-cost supplier—besting both **Johnson & Johnson** and **3M**. Tecnol's rapid expansion

[8] John P. Callan, Wesley N. Tredup, and Randy S. Wissinger, "Elgin Sweeper Company's Journey Toward Cost Management," *Management Accounting* (July 1991): 24–27.

CORNERSTONE 2-5

The HOW and WHY of Using Account Analysis to Determine Fixed and Variable Costs

Information:

The controller for Morrisey Company wants to determine the cost behaviour of factory overhead. Based on observation and discussions with plant workers, she feels that five accounts are most relevant. Two are fixed—supervisory salaries and depreciation—and the remaining three are variable. Indirect labour is primarily used to move materials and varies with number of moves. The largest component of utilities is electricity to run production machinery, which is driven by machine hours. Purchasing seems to be driven by the number of purchase orders. The accounts and their balances for the past six months are as follows:

	Indirect Labour Cost	Utilities	Purchasing	Supervisory Salaries	Plant & Equipment Depreciation
July	$ 14,250	$12,000	$ 38,200	$ 20,000	$ 6,500
August	15,800	10,600	35,400	23,000	6,500
September	16,800	12,500	37,600	32,000	6,500
October	20,700	12,500	40,200	27,800	6,500
November	20,000	12,500	39,900	25,400	6,500
December	17,000	12,500	39,700	17,000	6,500
Total	$104,550	$72,600	$231,000	$145,200	$39,000

Information on machine hours, number of moves, and number of purchase orders for the six-month period follows:

	Number of Moves	Machine Hours (Mhr)	Purchase Orders (PO)
July	340	5,400	300
August	380	5,200	250
September	400	5,800	380
October	500	6,200	450
November	480	6,000	340
December	420	5,600	200
Total	2,520	34,200	1,920

Why:

By separating accounts with primarily fixed costs from those with primarily variable costs, and associating the variable costs with relevant drivers, it is possible to determine cost behaviour and use it in budgeting, performance evaluation, and decision making.

Required:

1. Why did the controller decide that supervisory salaries and depreciation on the plant were fixed?
2. Calculate the average account balances for each of the five accounts. Calculate the average monthly amount of each of the three drivers.
3. Calculate the total fixed overhead for the month and the variable rates for indirect labour, utilities, and purchasing. Express the results in the form of an equation for total overhead cost.

CORNERSTONE 2-5 *(continued)*

4. In January, 490 moves, 4,375 machine hours, and 220 purchase orders are expected. What is the total overhead cost expected for the factory in January?
5. ***What if*** purchase orders predicted for January were 300? How would that affect the predicted overhead cost?

Solution:

1. Clearly, depreciation is fixed at $6,500 per month, and will not change unless equipment is bought or sold. While supervisory salaries did change during the six-month period, they were no doubt placed in the fixed category because they do not vary with the drivers under consideration: number of moves, machine hours, and purchase orders.

2. Average indirect labour cost = $104,550/6 = $17,425
   Average utilities = $72,600/6 = $12,100
   Average purchasing = $231,000/6 = $38,500
   Average supervisory salaries = $145,200/6 = $24,200
   Average depreciation = $39,000/6 = $6,500
   Average number of moves = 2,520/6 = 420
   Average machine hours = 34,200/6 = 5,700
   Average purchase orders = 1,920/6 = 320

3. Total fixed overhead cost = $24,200 + $6,500 = $30,700
   Variable rate for indirect labour = $17,425/420 = $41.49 per move (rounded)
   Variable rate for utilities = $12,100/5,700 = $2.12 per Mhr (rounded)
   Variable rate for purchasing = $38,500/320 = $120.31 per PO (rounded)
   Total overhead cost = $30,700 + $41.49(moves) + $2.12(machine hours) + 120.31(purchase orders)

4. Total overhead cost = $30,700 + ($41.49 × 490) + ($2.12 × 4,375) + ($120.31 × 220) = $86,773 (rounded)

5. If purchase orders increased by 80, then predicted January overhead cost would increase by $9,624.80 ($120.31 × 80) to a total of $96,398 (rounded).

into new product lines and European markets means that historical data on costs and revenues are, for the most part, irrelevant. Tecnol's management must look forward, not back, to predict the impact of changes on profit. Statistical techniques are highly accurate in depicting the past, but they cannot foresee the future, which of course is what management really wants.[9]

The advantage of using managerial judgment to separate fixed and variable costs is its simplicity. In situations in which the manager has a deep understanding of the firm and its cost patterns, this method can give good results. However, if the manager does not have good judgment, errors will occur. Therefore, it is important to consider the experience of the manager, the potential for error, and the effect that error could have on related decisions.

Multiple Regression

OBJECTIVE 6
Explain how multiple regression can be used to assess cost behaviour.

In the case of two explanatory variables (activity drivers), the linear equation is expanded to include the additional variable:

$$Y = F + V_1X_1 + V_2X_2$$

[9] Stephanie Anderson Forest, "Who's Afraid of J&J and 3M?" *Business Week* (December 5, 1994): 66, 68.

where

X_1 = Number of moves
X_2 = The total distance

With three variables (Y, X_1, X_2), a minimum of three points is needed to compute the parameters F, V_1, and V_2. Seeing the points becomes difficult because they must be plotted in three dimensions. Using the scatterplot method or the high-low method is not practical.

However, the extension of the method of least squares is straightforward. It is relatively simple to develop a set of equations that provides values for F, V_1, and V_2 that yield the best-fitting equation. Whenever least squares is used to fit an equation involving two or more independent variables, the method is called **multiple regression**. The computations required for multiple regression are far more complex than in simple (one independent variable) regression. In fact, any practical application of multiple regression requires use of a computer.

Let's return to the Anderson Company example. Recall that the R^2 is just 85 percent and that the fixed cost coefficient was not significant. Perhaps another variable can help explain materials handling costs. Suppose that Anderson Company's controller finds that in some months many more kilograms of materials were moved than in other months. The heavier materials required additional equipment to handle the increased load.

The controller adds the variable "kilograms moved" and gathers information on that variable for the 10 months. These data are shown below.

Month	Materials Handling Cost	Number of Moves	Kilograms Moved
January	$2,000	100	6,000
February	3,090	125	15,000
March	2,780	175	7,800
April	1,990	200	600
May	7,500	500	29,000
June	5,300	300	23,000
July	4,300	250	17,000
August	6,300	400	25,000
September	5,600	475	12,000
October	6,240	425	22,400

Multiple regression can be run using the number of moves and the number of kilograms moved as the independent variables. Running multiple regression using the Excel program is no more difficult than using it to run simple regression.

OBJECTIVE 7
Define the learning curve, and discuss its impact on cost behaviour.

The Learning Curve and Nonlinear Cost Behaviour

A number of cost behaviour patterns do not follow a linear pattern. We have already seen that total cost can increase at a decreasing rate, as is the case when there are discounts for large purchases of materials. An important type of nonlinear cost curve is the learning curve. The **learning curve** shows how the labour hours worked per unit decrease as the number of units produced increases. The basis of the learning curve is almost intuitive—as we perform an action over and over, we improve, and each additional performance takes less time than the preceding ones. We learn how to do the task, become more efficient, and smooth out the rough spots. In a manufacturing firm, learning takes place throughout the process: workers learn their tasks and managers learn to schedule production more efficiently and to arrange the flow of work. Each time cumulative volume doubles, costs fall by a constant and predictable percentage. This effect was first documented in the aircraft industry.

Managers can see that the ideas behind the learning curve can extend to the service industry as well as to manufacturing firms. Costs in marketing, distribution, and service after the sale also decrease as the number of units produced and sold increases. When used in this way, the learning curve is often called the experience curve. The **experience curve** relates cost to increased efficiency, such that the more often a task is performed, the lower will be the cost of doing it. The experience curve can be applied to any task, including production, selling, distribution, post-sales service, and so on.

The learning curve model takes two common forms: the cumulative average-time learning curve model and the incremental unit-time learning curve model. The difference between the two lies in the assumption made about the speed of learning.

Cumulative Average-Time Learning Curve

The **cumulative average-time learning curve model** states that the cumulative average time per unit decreases by a constant percentage, or learning rate, each time the cumulative quantity of units produced doubles. The **learning rate** is expressed as a percent, and it gives the percentage of time needed to make the next unit, based on the time it took to make the previous unit. The learning rate is determined through experience and must be between 50 and 100 percent. A 50 percent learning rate would eventually result in no labour time per unit—an absurd result. A 100 percent learning rate implies no learning (since the amount of decrease is zero). An 80 percent learning curve is often used to illustrate this model, possibly because the original learning curve work with the aircraft industry found an 80 percent learning curve. Cornerstone 2-6 shows how to calculate the amount of time needed for producing successive units given an 80 percent learning rate and 100 direct labour hours for the first unit.

Cornerstone 2-6 shows the cumulative average time and cumulative total time according to the doubling formula. How do we obtain these amounts for units that are not doubles of the original amount? This is done by realizing that the cumulative average-time learning model takes a logarithmic relationship.

$$Y = pX^q$$

where

$Y =$ Cumulative average time per unit
$X =$ Cumulative number of units produced
$p =$ Time in labour hours required to produce the first unit
$q =$ Rate of learning

Therefore:

$$q = \ln(\text{percent learning})/\ln 2$$

For an 80 percent learning curve:

$$q = -0.2231/0.6931 = -0.3219$$

So, when $X = 3$, $p = 100$, and $q = -0.3219$,

$$Y = 100 \times 3^{-0.3219} = 70.21 \text{ labour hours}$$

Excel can be used to calculate the number of hours required for units that are not doubles of the first. Exhibit 2-10 shows an Excel screenshot for the example from Cornerstone 2-6. The rows in bold are the cumulative number of units that obey the doubling rule. Cornerstone 2-6 tells how to calculate columns C and D for those rows. For row 7, corresponding to 3 units, follow the following steps:

Step 1: Cell F5: enter "=LN(0.8)/LN(2)". After the value "–0.32192809" appears, copy the cell and then paste it into cells F5 through F20.

Step 2: Cell A7: enter "3"

CORNERSTONE 2-6

The HOW and WHY of Calculating the Cumulative Average-Time Learning Curve

Information:

Lindstrom Company installs computerized patient record systems in hospitals and medical centres. Lindstrom has noticed that each general type of system is subject to an 80 percent learning curve. The installation takes a team of professionals to set up and test the system. Assume that the first installation takes 1,000 hours, and the team of professionals is paid an average of $50 per hour.

Why:

As learning occurs, workers become more familiar with the task and can complete it more quickly. The first system installed takes the longest time; by the eighth to sixteenth time the task is performed, the workers have incorporated learning effects and the task takes much less time. Managers need to know how quickly the learning will occur and what effect that will have on labour cost for budgeting, bidding, and performance evaluation.

Required:

1. Set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, and cumulative total time in hours. Show results by row for total production of one system, two systems, four systems, eight systems, sixteen systems, and thirty-two systems.
2. What is the total labour cost if Lindstrom installs the following number of systems: one; four; sixteen? What is the average cost per installed system for the following number of systems: one, four, sixteen?
3. ***What if*** Lindstrom is budgeting labour cost for next year based on the installation of 16 additional systems? Calculate total budgeted labour cost for a team that had previously completed 16 systems the prior year. Calculate total budgeted labour cost for a new team that had not completed any systems to date.

Solution:

1.

Cumulative Number of Systems (1)	Cumulative Average Time per System in Hours (2)	Cumulative Total Time: Labour Hours (3) = (1) × (2)
1	1,000	1,000.0
2	800.0 (0.8 × 1,000)	1,600.0
4	640.0 (0.8 × 800)	2,560.0
8	512.0 (0.8 × 640)	4,096.0
16	409.6 (0.8 × 512)	6,553.6
32	327.7 (0.8 × 409.6)	10,486.4

Notice that every time the number of systems installed doubles, the cumulative average time per unit (in column 2) is just 80 percent of the previous amount.

CORNERSTONE 2-6 *(continued)*

2. Cost for installing one system = 1,000 hours × $50 = $50,000
   Cost for installing four systems = 2,560 hours × $50 = $128,000
   Cost for installing sixteen systems = 6,553.6 hours × $50 = $327,680
   Average cost per system for one system = $50,000/1 = $50,000
   Average cost per system for four systems = $128,000/4 = $32,000
   Average cost per system for sixteen systems = $327,680/16 = $20,480

3. Budgeted labour cost for experienced team = (10,486.4 − 6,553.6) × $50
   = $196,640
   Budgeted labour cost for new team = 6,553.6 × $50 = $327,680

Step 3: Cell B7: enter "=1000*POWER(A7,F7)" You are entering "1000" because that is the cumulative average time per unit for one unit. In different examples, you will enter a different cumulative average time per unit for one unit. That is, if the first unit had taken 78 hours, you would have entered "=78*POWER(A7,F7)"

Step 4: Cell C7: enter "=A7*B7"

Step 5: Cell D7: enter "=C7-C6"

You can now copy and paste cell B7 into cells B8 through B20, cell C7 into cells C8 through C20, and so on.

Let's take a closer look at the time for the last unit in Exhibit 2-10. See how the time it takes to complete the last unit drops from the first unit (1,000 hours) to the sixteenth unit (just 280.6 hours). This learning helps companies realize efficiencies as more and more units are completed. Accountants can use this information in budgeting and preparing bids, as they realize that the time for the first unit of a new type of job will not be equal to the time it takes to complete the last unit. Cost goes down. Accountants can also use this information to advise managers on the need to keep experienced employees rather than having excessive turnover. The turnover requires more training and does not give the company the benefit of the experienced employee's ability to do the job more quickly and competently.

Exhibit 2-11 shows the graph of both the cumulative average time per unit (the bottom line) and the cumulative total hours required (top line). We can see that the time per unit decreases as output increases, but that it decreases at a decreasing rate. We also see that the total labour hours increase as output increases, but they increase at a decreasing rate. Again, the implication for costing is that average cost will decrease as more experience is gained.

Incremental Unit-Time Learning Curve

The **incremental unit-time learning curve model** decreases by a constant percentage each time the cumulative quantity of units produced doubles. The same general assumptions for the learning curve hold; however, the learning rate is assumed to apply to the last unit produced, not to the cumulative average of all units to date. For an 80 percent learning rate, the cumulative average-time learning model assumes that the cumulative *average* time for every unit produced is just 80 percent of the amount for the previous output level. Thus, when we look at the time to produce two units, the average time for each of the units is assumed to be 80 percent of the time for the first unit. However, the incremental unit-time learning model assumes that only the *last* (incremental) unit experiences the decrease in time, so the second unit takes 80 hours, but the first still takes 100 hours. Thus, the total time is 180 (100 + 80) hours. Further explanation of the incremental unit-time learning curve will be left for more advanced courses.

Exhibit 2-10

Spreadsheet for Cumulative Average-Time Learning Model

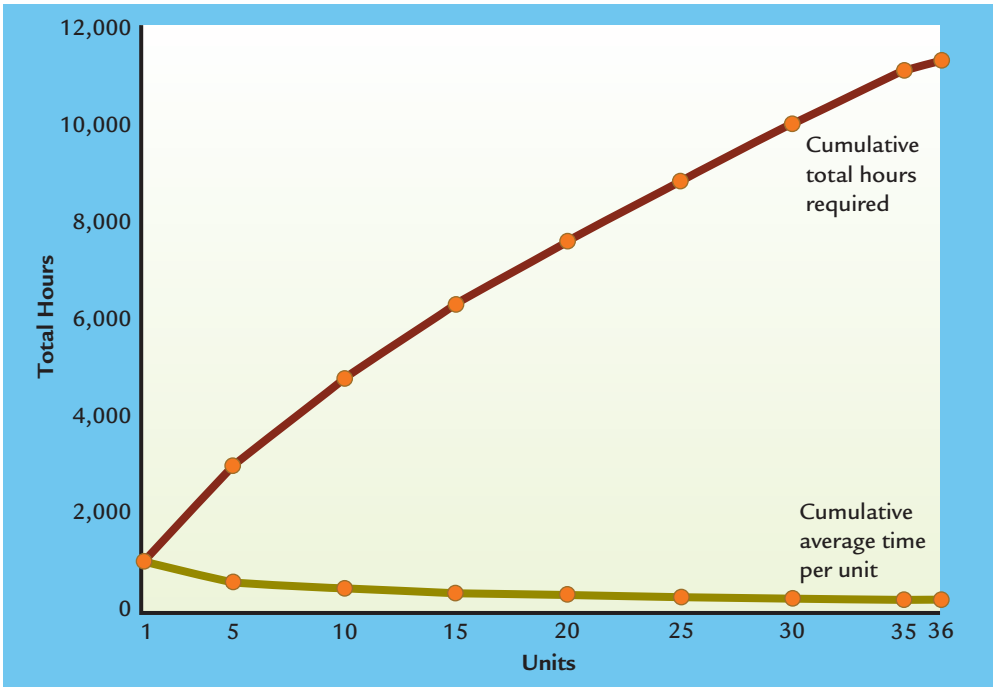
Cumulative Average Time Learning Model.xls

	A	B	C	D	E	F
1	**Cornerstone 2-6**					
2	**Cumulative Average-Time Learning Model**					
3						
4	Cumulative Number of Units	Cumulative Average Time per Unit	Cumulative Total Time	Time for Last Unit		Value of q OR = ln(.8)/ln(2)
5	1	1000	1000	1000		–0.32192809
6	**2**	**800**	**1600**	**600**		**–0.32192809**
7	3	702.1037028	2106.31111	506.3111		–0.32192809
8	**4**	**640**	**2560**	**453.6889**		**–0.32192809**
9	5	595.6373436	2978.18672	418.1867		–0.32192809
10	6	561.6829622	3370.09777	391.9111		–0.32192809
11	7	534.4895247	3741.42667	371.3289		–0.32192809
12	**8**	**512**	**4096**	**354.5733**		**–0.32192809**
13	9	492.9496095	4436.54649	340.5465		–0.32192809
14	10	476.5098749	4765.09875	328.5523		–0.32192809
15	11	462.1111387	5083.22253	318.1238		–0.32192809
16	12	449.3463698	5392.15644	308.9339		–0.32192809
17	13	437.9155217	5692.90178	300.7453		–0.32192809
18	14	427.5916197	5986.28268	293.3809		–0.32192809
19	15	418.1991845	6272.98777	286.7051		–0.32192809
20	**16**	**409.6**	**6553.6**	**280.6122**		–0.32192809
21						
22						

Sheet1 Sheet2 Sheet3

Exhibit 2-11

Graph of Cumulative Total Hours Required and the Cumulative Average Time per Unit



The use of the learning curve concepts permits management to be more accurate in budgeting and performance evaluation for processes in which learning occurs. While the learning curve was originally developed for manufacturing processes, it can also apply in service industries. For example, insurance companies develop new policies and new methods of selling policies. There is a learning component to each new policy as employees discover glitches that were unexpected in the development process and then learn how to fix those glitches and become more efficient.

Summary of Learning Objectives

1. Define and describe fixed, variable, and mixed costs.

- Variable costs change in total as activity usage changes.
- Usually, variable costs increase in direct proportion to increases in activity output.
- Fixed costs do not change in total as activity output changes.
- Mixed costs have both a variable and a fixed component.

2. Explain the use of resources and activities and their relationship to cost behaviour.

- Flexible resources are acquired as used and needed.
  - Flexible resources have no excess capacity for these resources.
  - They are usually considered to be variable costs.
- Committed resources are acquired in advance of usage.
  - May have excess capacity
  - Frequently considered fixed
- Step costs are acquired in lumpy amounts.
  - Narrow steps approximated by a variable cost function
  - Wide steps approximated as fixed

3. Separate mixed costs into their fixed and variable components using the high-low method, the scatterplot method, and the method of least squares.

- High-low method uses the high and the low data points to form a straight line.
  - Slope is variable rate.
  - Intercept is fixed cost.
  - Advantages: objective and easy
  - Disadvantage: nonrepresentative high or low point leads to misestimated cost function
- Scatterplot method plots data—two points chosen to determine a line
  - Intercept is fixed cost.
  - Slope is variable rate.
  - Advantages: identify nonlinearity, outliers, shifts in the cost relationship
  - Disadvantage: subjectivity

4. Evaluate the reliability of the cost formula.

- Coefficient of correlation shows degree to which two variables move together.
  - Perfect positive correlation = 1.0
  - Perfect negative correlation = −1.0

- Coefficient of determination (R^2) shows amount of cost variability explained by driver.
  - $0 \leq R^2 \leq 1.0$
  - Often multiplied by 100 and used as percent
- Standard error of estimate used to build a prediction interval for cost

5. Discuss the use of managerial judgment in determining cost behaviour.

- Used alone or in conjunction with the high-low, scatterplot, or least-squares methods.
- Experienced managers use knowledge to identify outliers, adjust parameters, and anticipate changing conditions.

6. Explain how multiple regression can be used to assess cost behaviour.

- Has two or more independent variables
- Useful when dependent variable is affected by more than one independent variable

7. Define the learning curve, and discuss its impact on cost behaviour.

- Nonlinear relationship between labour hours and output
- Doubling of output requires less than a doubling of labour time.
- Cumulative average-time learning curve assumes the cumulative average time per unit decreases by a constant percentage, or learning rate, each time the cumulative quantity of units produced doubles.
- Incremental unit-time learning curve assumes the incremental unit time decreases by a constant percentage each time the cumulative quantity of units produced doubles.

CORNERSTONES FOR CHAPTER 2

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Review Problems

I. Resource Usage and Cost Behaviour

Thompson Manufacturing Company has three salaried clerks to process purchase orders. Each clerk is paid a salary of $28,000 and is capable of processing 5,000 purchase orders per year (working efficiently). In addition to the salaries, Thompson spends $7,500 per year for forms, postage, etc. Thompson assumes 15,000 purchase orders will be processed. During the year, 12,500 orders were processed.

Required:

1. Calculate the activity rate for the purchase order activity. Break the activity into fixed and variable components.

2. Compute the total activity availability, and break this into activity output and unused activity.
3. Calculate the total cost of the resource supplied, and break this into the cost of activity output and the cost of unused activity.

Solution:

1.
$$\begin{aligned}\text{Activity rate} &= [(3 \times \$28{,}000) + \$7{,}500]/15{,}000\\ &= \$6.10/\text{order}\\ \text{Fixed rate} &= \$84{,}000/15{,}000\\ &= \$5.60/\text{order}\\ \text{Variable rate} &= \$7{,}500/15{,}000\\ &= \$0.50/\text{order}\end{aligned}$$

2.
$$\begin{aligned}\text{Activity availability} &= \text{Activity output} + \text{Unused activity}\\ 15{,}000\ \text{orders} &= 12{,}500\ \text{orders} + 2{,}500\ \text{orders}\end{aligned}$$

3.
$$\begin{aligned}\text{Cost of activity supplied} &= \text{Cost of activity output} + \text{Cost of unused activity}\\ \$84{,}000 + (\$0.50 \times 12{,}500) &= (\$6.10 \times 12{,}500) + (\$5.60 \times 2{,}500)\\ \$90{,}250 &= \$76{,}250 + \$14{,}000\end{aligned}$$

II. High-Low Method and Method of Least Squares

Linda Jones, an accountant for Golding Inc., has decided to estimate the fixed and variable components associated with the company's repair activity. She has collected the following data for the past six months:

Repair Hours	Total Repair Costs
10	$ 800
20	1,100
15	900
12	900
18	1,050
25	1,250

Required:

1. Estimate the fixed and variable components for the repair costs using the high-low method. Using the cost formula, predict the total cost of repair if 14 hours are used.
2. Estimate the fixed and variable components using the method of least squares. Translate your results into the form of a cost formula, and using that formula, predict the total cost of repairs if 14 hours are used.
3. Using the method of least squares, what are the coefficient of determination and the coefficient of correlation?

Solution:

1. The estimate of fixed and variable costs using the high-low method, where Y = total cost and X = number of hours, is as follows:

$$\begin{aligned}V &= (Y_2 - Y_1)/(X_2 - X_1)\\ &= (\$1{,}250 - \$800)/(25 - 10)\\ &= \$450/15\\ &= \$30\ \text{per hour}\\ F &= Y_2 - VX_2\\ &= \$1{,}250 - \$30(25)\\ &= \$500\\ Y &= \$500 + \$30X\\ &= \$500 + \$30(14)\\ &= \$920\end{aligned}$$

2. Regression is performed using Excel, with the results as follows:

Summary Output

Regression Statistics

Multiple R	0.984523
R^2	0.969285
Adjusted R^2	0.961607
Standard Error	32.19657
Observations	6

ANOVA

	df	SS	MS	F	Significance F
Regression	1	130853.5	130853.5	126.2311	0.000357
Residual	4	4146.476	1036.619		
Total	5	135000			

	Coefficients	Standard Error	t Stat	*P*-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	509.9119	45.55789	11.19261	0.000363	383.4227	636.4011	383.4227	636.4011
X Variable 1	29.40529	2.617232	11.23526	0.000357	22.13867	36.6719	22.13867	36.6719

The calculation using the method of least squares is as follows:

$$\begin{aligned} Y &= \$509.91 + \$29.41X \\ &= \$509.91 + \$29.41(14) \\ &= \$921.65 \end{aligned}$$

3. The coefficient of determination (R^2) is 0.962, and the correlation coefficient (r) is 0.984 (the square root of 0.969).

Key Terms

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Discussion Questions

1. Why is knowledge of cost behaviour important for managerial decision making? Give an example to illustrate your answer.
2. How does the length of the time horizon affect the classification of a cost as fixed or variable? What is the meaning of short run? Long run?
3. Explain the difference between resource spending and resource usage.
4. What is the relationship between flexible resources and cost behaviour?
5. What is the relationship between committed resources and cost behaviour?
6. Describe the difference between a variable cost and a step-variable cost. When is it reasonable to treat step-variable costs as if they were variable costs?
7. Why do mixed costs pose a problem when it comes to classifying costs into fixed and variable categories?
8. Why is a scattergraph a good first step in separating mixed costs into their fixed and variable components?
9. What are the advantages of the scatterplot method over the high-low method? The high-low method over the scatterplot method?
10. Describe the method of least squares. Why is this method better than either the high-low method or the scatterplot method?
11. What is meant by the best-fitting line? Is the best-fitting line necessarily a good-fitting line? Explain.
12. When is multiple regression required to explain cost behaviour?
13. Explain the meaning of the learning curve. How do managers determine the appropriate learning curve percentage to use?
14. Assume you are the manager responsible for implementing a new service. The time to perform the service is subject to the learning curve. Would you prefer that the new service have a learning rate of 85 percent or 80 percent? Why?
15. Some firms assign mixed costs to either the fixed or variable cost categories without using any formal methodology to separate them. Explain how this practice can be defended.

Cornerstone Exercises

Cornerstone Exercise 2-1 MIXED COSTS AND COST FORMULA

OBJECTIVE 1
CORNERSTONE 2-1
SERVICE

Bo's Gym is a complete fitness centre. Owner Bo Sanderson employs various fitness trainers who are expected to staff the front desk and to teach fitness classes. While on the front desk, trainers answer the phone, handle walk-ins and show them around the gym, answer member questions about the weight machines, and do light cleaning (wiping down the equipment, vacuuming the floor). The trainers also teach fitness classes (e.g., pilates, spinning, body pump) according to their own interest and training level. The cost of the fitness trainers is $500 per month and $25 per class taught. Last month, 100 classes were taught.

Required:

1. Develop a cost equation for total cost of labour.
2. What was total variable labour cost last month?
3. What was total labour cost last month?
4. What was the unit cost of labour (per class) for last month?
5. ***What if*** Bo increased the number of classes offered by 100 percent? What would be the total labour cost? The unit labour cost? Explain why the unit labour cost decreased.

Cornerstone Exercise 2-2 ACTIVITY AVAILABILITY, CAPACITY USED, UNUSED CAPACITY

OBJECTIVE 2
CORNERSTONE 2-2
SERVICE

Metternich Company has a Purchasing Department staffed by four purchasing agents. Each agent is paid $30,000 per year and is able to process 3,000 purchase orders. Last year, 10,000 purchase orders were processed by the four agents.

Required:

1. Calculate the activity rate per purchase order.
2. Calculate, in terms of purchase orders, the:
   a. total activity availability
   b. unused capacity
3. Calculate the dollar cost of:
   a. total activity availability
   b. unused capacity
4. Express total activity availability in terms of activity capacity used and unused capacity.
5. ***What if*** one of the purchasing agents agreed to work half time for $15,000? How many purchase orders could be processed by three and a half purchasing agents? What would unused capacity be in purchase orders?

OBJECTIVE 3

CORNERSTONE 2-3

SERVICE

Cornerstone Exercise 2-3 HIGH-LOW METHOD TO DETERMINE FIXED COST AND VARIABLE RATE

White Swan, a health care facility, had the following 12 months of data on purchasing cost and number of purchase orders.

Month	Purchasing Cost	Number of Purchase Orders
January	$20,068	330
February	20,890	370
March	20,750	410
April	22,050	400
May	21,900	450
June	21,300	460
July	23,426	560
August	21,670	440
September	22,250	500
October	21,200	470
November	21,800	480
December	20,800	370

Required:

1. Determine the high point and the low point.
2. Calculate the variable rate for purchasing cost based on the number of purchase orders.
3. Calculate the fixed monthly cost of purchasing.
4. Write the cost formula for the purchasing activity showing the fixed cost and the variable rate.
5. If White Swan estimates that next month will have 430 purchase orders, what is the total estimated purchasing cost for that month?
6. ***What if*** White Swan wants to estimate purchasing cost for the coming year and expects 5,340 purchase orders? What will estimated total purchasing cost be? What is the total fixed purchasing cost? Why doesn't it equal the fixed cost calculated in Requirement 3 above?

OBJECTIVE 3

CORNERSTONE 2-4

SERVICE

Cornerstone Exercise 2-4 USING REGRESSION RESULTS TO CONSTRUCT AND APPLY A COST FORMULA

White Swan had the following 12 months of data on purchasing cost and number of purchase orders.

Month	Purchasing Cost	Number of Purchase Orders
January	$20,068	330
February	20,890	370
March	20,750	410
April	22,050	400
May	21,900	450
June	21,300	460
July	23,426	560
August	21,670	440
September	22,250	500
October	21,200	470
November	21,800	480
December	20,800	370

The controller for White Swan ran regression on the above data, and the coefficients shown by the regression program (rounded to the nearest cent) are:

Intercept	16,403.85
X variable 1	11.69

Required:

1. Construct the cost formula for the purchasing activity showing the fixed cost and the variable rate.
2. If White Swan estimates that next month will have 430 purchase orders, what is the total estimated purchasing cost for that month? (Round your answer to the nearest dollar.)
3. ***What if*** White Swan wants to estimate purchasing cost for the coming year and expects 5,340 purchase orders? What will estimated total purchasing cost be? (Round your answer to the nearest dollar.) What is the total fixed purchasing cost? Why doesn't it equal the fixed cost calculated in Requirement 1 above?

OBJECTIVE 5

CORNERSTONE 2-5

SERVICE

Cornerstone Exercise 2-5 ACCOUNT ANALYSIS TO DETERMINE COST BEHAVIOUR

Lance Leffler, owner of Leffler Inc., a warehousing facility, wants to determine the cost behaviour of labour and overhead. Lance pays his workers a salary; during busy times, everyone works to get the orders out. Temps (temporary workers hired through an agency) may be hired to pack and prepare completed orders for shipment. During slower times, Lance catches up on bookkeeping and administrative tasks while the salaried workers do preventive maintenance, clean the lines and building, etc. Temps are not hired during slow times. Lance found that workers' salaries, temp agency payments, rentals, utilities, and plant and equipment depreciation are the largest dollar accounts. He believes that workers' salaries and plant and equipment depreciation are fixed, temp agency payments are associated with the number of orders (since temp workers are used to pack and prepare completed orders for shipment), and electricity is associated with the number of machine hours. When the number of different parts stored by Leffler exceeds the space in the materials storeroom, Lance rents nearby warehouse space. He can rent as much or as little space as he wants on a month-to-month basis. Therefore, he believes warehouse rental payments are variable with the number of parts purchased and stored. The account balances for the past six months as well as the six-month total are as follows:

	Workers' Salaries	Temp Agency Payments	Warehouse Rental	Electricity	Plant & Equipment Depreciation
January	$ 6,300	$ 0	$ 150	$ 300	$ 2,800
February	6,300	320	400	410	2,800
March	6,300	1,200	460	680	2,800
April	6,300	1,350	500	720	2,800
May	6,300	1,750	480	750	2,800
June	6,300	1,400	220	700	2,800
Total	$37,800	$6,020	$2,210	$3,560	$16,800

Information on number of machine hours, orders, and parts for the six-month period follows:

	Machine Hours	Number of Orders	Number of Parts
January	2,000	10	200
February	3,100	40	450
March	5,800	350	550
April	6,200	400	580
May	6,500	510	480
June	6,000	410	300
Total	29,600	1,720	2,560

Required:

1. Calculate the monthly average account balance for each account. Calculate the average monthly amount for each of the three drivers.
2. Calculate fixed monthly cost and the variable rates for temp agency payments, warehouse rent, and electricity. Express the results in the form of an equation for total cost.
3. In July, Lance predicts there will be 400 orders, 280 parts, and 5,900 machine hours. What is the total labour and overhead cost for July?
4. ***What if*** Lance buys a new machine in July for $18,000? The machine is expected to last 10 years and will have no salvage value at the end of that time. What part of the cost equation will be affected? How? What is the new expected cost in July?

OBJECTIVE 6

CORNERSTONE 2-4

SERVICE

Cornerstone Exercise 2-6 USING MULTIPLE REGRESSION RESULTS TO CONSTRUCT AND APPLY A COST FORMULA

The controller for White Swan Company felt that the number of purchase orders alone did not explain the monthly purchasing cost. He knew that nonstandard orders (e.g., one requiring an overseas supplier) took more time and effort. He collected data on the number of nonstandard orders for the past 12 months and added that information to the data on purchasing cost and number of purchase orders.

Month	Purchasing Cost	Number of Purchase Orders	Number of Nonstandard Orders
January	$20,068	330	35
February	20,890	370	61
March	20,750	410	14
April	22,050	400	73
May	21,900	450	55
June	21,300	460	30
July	23,426	560	80
August	21,670	440	51
September	22,250	500	50
October	21,200	470	12
November	21,800	480	27
December	20,800	370	53

Multiple regression was run on the above data; the coefficients shown by the regression program (rounded to the nearest cent) are:

Intercept	15,866.55
X variable 1	10.90
X variable 2	19.54

Required:

1. Construct the cost formula for the purchasing activity showing the fixed cost and the variable rate.

2. If White Swan estimates that next month will have 430 purchase orders and 45 non-standard orders, what is the total estimated purchasing cost for that month? (Round your answer to the nearest dollar.)
3. ***What if*** White Swan wants to estimate purchasing cost for the coming year and expects 5,340 purchase orders and 580 nonstandard orders? What will estimated total purchasing cost be? What is the total fixed purchasing cost? Why doesn't it equal the fixed cost calculated in Requirement 2 above? (Round your answers to the nearest dollar.)

Cornerstone Exercise 2-7 CUMULATIVE AVERAGE-TIME LEARNING CURVE

OBJECTIVE 7

CORNERSTONE 2-6

Tam Company makes aircraft engines. Tam has noticed that, in general, each new engine design is subject to an 85 percent learning rate. Assume that the first unit produced takes 400 hours, and direct labour is paid an average of $30 per hour.

Required:

1. Set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, and cumulative total time in hours. Show results by row for total production of one engine, two engines, four engines, eight engines, sixteen engines, and thirty-two engines. (Round hour answers to two significant digits.)
2. What is the total labour cost if Tam manufactures the following number of engines: one; four; sixteen? What is the average cost per engine for the following number of engines: one, four, sixteen? (Round your answers to the nearest dollar.)
3. ***What if*** Tam is preparing a bid to build 16 engines? Calculate budgeted labour cost for an engine design that Tam has built before (assume that 16 of these engines had been made previously and the first unit took 400 hours). Calculate budgeted labour cost for a new engine design that Tam's workers have never made before (assume the first unit will take 400 hours).

Exercises

Exercise 2-8 VARIABLE, FIXED, AND MIXED COSTS

OBJECTIVE 1

SERVICE

Classify the following costs of activity inputs as variable, fixed, or mixed. Identify the activity and the associated activity driver that allow you to define the cost behaviour. For example, assume that the resource input is "cloth in a shirt." The activity would be "sewing shirts," the cost behaviour "variable," and the activity driver "units produced." Prepare your answers in the following format:

Activity	Cost Behaviour	Activity Driver
Sewing shirts	Variable	Units produced

a. Flu vaccine
b. Salaries, equipment, and materials used for moving materials in a factory
c. Forms used to file insurance claims
d. Salaries, forms, and postage associated with purchasing
e. Printing and postage for advertising circulars
f. Equipment, labour, and parts used to repair and maintain production equipment
g. Power to operate sewing machines in a clothing factory
h. Wooden cabinets enclosing audio speakers
i. Advertising
j. Sales commissions
k. Fuel for a delivery van
l. Depreciation on a warehouse
m. Depreciation on a forklift used to move partially completed goods
n. X-ray film used in the Radiology Department of a hospital
o. Rental car provided for a client

OBJECTIVE 1

Exercise 2-9 COST BEHAVIOUR

SERVICE

Logic Inc. is a data processing firm. Based on past experience, Logic has found that its total annual overhead costs can be represented by the following formula: Overhead cost = $720,000 + 0.90X$, where X equals number of clients. Last year, Logic served 25,000 clients. Actual overhead costs for the year were as expected.

Required:

1. What is the driver for the overhead activity?
2. What is the total overhead cost incurred by Logic last year?
3. What is the total fixed overhead cost incurred by Logic last year?
4. What is the total variable overhead cost incurred by Logic last year?
5. What is the overhead cost per client served?
6. What is the fixed overhead cost per client?
7. What is the variable overhead cost per client?
8. Recalculate Requirements 5, 6, and 7 for the following levels of clientele: (a) 22,000 clients and (b) 27,000. (Round your answers to the nearest cent.) Explain this outcome.

OBJECTIVE 1

Exercise 2-10 TYPES OF COSTS

Cashion Company produces chemical mixtures for veterinary pharmaceutical companies. Its factory has four mixing lines that mix various powdered chemicals together according to specified formulas. Each line can produce up to 5,000 barrels per year. Each line has one supervisor who is paid $34,000 per year. Depreciation on equipment averages $16,000 per year. Direct materials and power cost about $4.50 per unit.

Required:

1. Prepare a graph for each of these three costs: equipment depreciation, supervisors' wages, and direct materials and power. Use the vertical axis for cost and the horizontal axis for units (barrels). Assume that sales range from 0 to 20,000 units.
2. Assume that the normal operating range for the company is 16,000 to 19,000 units per year. How would you classify each of the three types of cost?

OBJECTIVE 2

Exercise 2-11 RESOURCE USAGE MODEL AND COST BEHAVIOUR

SERVICE

For the following activities and their associated resources, identify the following: (1) a cost driver, (2) flexible resources, and (3) committed resources. Also, label each resource as one of the following with respect to the cost driver: (a) variable or (b) fixed.

Activity	Resource Description
Maintenance	Equipment, labour, and parts
Inspection	Test equipment, inspectors (each inspector can inspect five batches per day), and units inspected (process requires destructive sampling*)
Packing	Materials, labour (each packer places five units in a box), and conveyor belt
Payable processing	Clerks, materials, equipment, and facility
Assembly	Conveyor belt, supervision (one supervisor for every three assembly lines), direct labour, and materials

*Destructive sampling occurs whenever it is necessary to destroy a unit as inspection occurs.

OBJECTIVE 2

Exercise 2-12 RESOURCE USAGE AND SUPPLY, ACTIVITY RATES, SERVICE ORGANIZATION

SERVICE

EnviroLabs performs tests on water samples supplied by outside companies to ensure that their waste water meets environmental standards. Customers deliver water samples to the lab and receive the lab reports via the Internet. The EnviroLabs facility is built and

staffed to handle the processing of 100,000 tests per year. The lab facility cost $250,000 to build and is expected to last 10 years and will have no salvage value. Processing equipment cost $245,500 and has a life expectancy of five years and will have no salvage value. Both facility and equipment are depreciated on a straight-line basis. EnviroLabs has eight salaried laboratory technicians, each of whom is paid $24,000. In addition to the salaries, facility, and equipment, EnviroLabs expects to spend $60,000 for chemicals and other supplies (assuming 100,000 tests are performed). Last year, 86,000 tests were performed.

Required:

1. Classify the resources associated with the water testing activity into one of the following types: (1) committed resources or (2) flexible resources.
2. Calculate the total annual activity rate for the water testing activity. Break the activity rate into fixed and variable components. (Round your answers to three significant digits.)
3. Compute the total activity availability, and break this into activity output and unused activity.
4. Calculate the total cost of resources supplied, and break this into the cost of activity used and the cost of unused activity.

Exercise 2-13 STEP COSTS, RELEVANT RANGE

OBJECTIVE 1 2

SERVICE

Eastern University has a group of tutors assisting schoolmates with their studies. Each tutor is paid $25,000 and can tutor up to 500 students per year. Eastern also hires supervisors to oversee the work of the tutors. Given the planning and supervisory work, a supervisor can oversee three tutors, at most. Eastern's accounting history reveals the following relationships between students tutored and the costs of direct labour (tutors) and supervision (measured on an annual basis):

Students served	Direct Labour	Supervision
0–500	$ 25,000	$ 40,000
501–1,000	50,000	40,000
1,001–1,500	75,000	40,000
1,501–2,000	100,000	80,000
2,001–2,500	125,000	80,000
2,501–3,000	150,000	80,000
3,001–3,500	175,000	120,000
3,501–4,000	200,000	120,000

Required:

1. Prepare two graphs: one that illustrates the relationship between direct labour cost and students tutored and one that illustrates the relationship between the cost of supervision and students tutored. Let cost be the vertical axis and students tutored the horizontal axis.
2. How would you classify each cost? Why?
3. Suppose that the normal range of activity is between 2,400 and 2,450 students and that the exact number of tutors is currently hired to support this level of activity. Further suppose that tutored students for the next year is expected to increase by an additional 400 students. How much will the cost of direct labour increase (and how will this increase be realized)? Cost of supervision?

Exercise 2-14 ACCOUNT ANALYSIS METHOD

OBJECTIVE 5

SERVICE

Penny LeClerc runs the Shear Beauty Salon near a university campus. Several months ago, Penny used some unused space at the back of the salon and bought two used tanning beds. She hired a receptionist and kept the salon open for extended hours each week so that tanning clients would be able to use the benefits of their tanning packages. After

three months, Penny wanted additional information on the costs of the tanning area. She accumulated the following data on four accounts:

	Wages	Supplies & Maintenance	Equipment Depreciation	Electricity	Tanning Minutes	Number of Visits
January	$1,750	$1,450	$150	$300	4,100	410
February	1,670	1,900	150	410	3,890	380
March	1,800	4,120	150	680	6,710	560

Penny decided that wages and equipment depreciation were fixed. She thought supplies and maintenance would vary with the number of tanning visits and that electricity would vary with the number of tanning minutes.

Required:

1. Calculate the average account balance for each account. Calculate the average monthly amount for each of the two drivers. (Round all answers to the nearest dollar or the nearest whole unit.)
2. Calculate fixed monthly cost and the variable rates for the account averages. (Round to the nearest cent.) Express the results in the form of an equation for total cost.
3. In April, Penny predicts there will be 360 visits for a total of 3,700 minutes. What is the total cost for April?
4. Suppose that Penny decides to buy a new tanning bed at the beginning of April for $6,960. The tanning bed is expected to last four years and will have no salvage value at the end of that time. What part of the cost equation will be affected? How? What is the new expected cost in April?

OBJECTIVE 5

Exercise 2-15 ACCOUNT ANALYSIS METHOD

SERVICE

Salman Khan is the accountant for several pizza restaurants based in a tri-city area. The president of the chain wanted some help with budgeting and cost control so Salman decided to analyze the accounts for the past year. He divided the accounts into four different categories, depending on whether they appeared to be primarily fixed or to vary with one of three different drivers. Food and wage costs appeared to vary with the total sales dollars. Delivery costs varied with the number of kilometres driven (workers were required to use their own cars and were reimbursed for kilometres driven). A group of other costs, including purchasing, materials handling, purchases of kitchen equipment, dishes and pans, appeared to vary with the number of different product types (e.g., pizza, salad, lasagna). Salman came up with the following monthly averages:

Food and wage costs	$175,000
Delivery costs	$18,000
Other costs	$9,520
Fixed costs	$255,000
Sales revenue	$560,000
Delivery mileage in kilometres	8,000
Number of product types	14

Required:

1. Calculate the average variable rate for the following costs: food and wages, delivery costs, other costs.
2. Form an equation for total cost based on the fixed costs and your results from Requirement 1.
3. The president is considering expanding the restaurant menu and plans to add one new offering to the menu. According to the cost equation, what is the additional monthly cost for the new menu offering?

OBJECTIVE 3

Exercise 2-16 SCATTERGRAPH METHOD, HIGH-LOW METHOD

SERVICE

Deepa Dalal opened a free-standing radiology clinic. She had anticipated that the costs for the radiological tests would be primarily fixed, but she found that costs increased

with the number of tests performed. Costs for this service over the past nine months are as follows:

Month	Radiology Tests	Total Cost
January	2,800	$133,500
February	2,600	135,060
March	3,100	175,000
April	3,500	170,600
May	3,400	176,900
June	3,700	186,600
July	3,840	174,450
August	4,100	195,510
September	3,450	185,300

Required:

1. Prepare a scattergraph based on the preceding data. Use cost for the vertical axis and number of radiology tests for the horizontal axis. Based on an examination of the scattergraph, does there appear to be a linear relationship between the cost of radiology service and the number of tests?
2. Compute the cost formula for radiology services using the high-low method.
3. Calculate the predicted cost of radiology services for October for 3,500 tests using the formula found in Requirement 2.

Exercise 2-17 METHOD OF LEAST SQUARES, GOODNESS OF FIT

OBJECTIVE 3 4

SERVICE

Refer to the data in **Exercise 2-16**.

Required:

1. Compute the cost formula for radiology services using the method of least squares.
2. Using the formula computed in Requirement 1, what is the predicted cost of radiology services for October for 3,500 appointments?

Exercise 2-18 HIGH-LOW METHOD, COST FORMULAS

OBJECTIVE 3

SERVICE

The controller of Monarch Grocers Inc. a major chain of grocery stores, monitored activities associated with materials handling costs. The high and low levels of resource usage occurred in September and March for three different resources associated with materials handling. The number of moves is the driver. The total costs of the three resources and the activity output, as measured by moves for the two different levels, are presented as follows:

Resource	Number of Moves	Total Cost
Forklift depreciation:		
Low	6,500	$ 1,800
High	20,000	1,800
Indirect labour:		
Low	6,500	74,250
High	20,000	135,000
Fuel and oil for forklift:		
Low	6,500	4,940
High	20,000	15,200

Required:

1. Determine the cost behaviour formula of each resource. Use the high-low method to assess the fixed and variable components.
2. Using your knowledge of cost behaviour, predict the cost of each item for an activity output level of 9,000 moves.
3. Construct a cost formula that can be used to predict the total cost of the three resources combined. Using this formula, predict the total materials handling cost if activity output is 9,000 moves. In general, when can cost formulas be combined to form a single cost formula?

OBJECTIVE 3 4

Exercise 2-19 METHOD OF LEAST SQUARES, EVALUATION OF COST EQUATION

SERVICE

A company used the method of least squares to develop a cost equation to predict the cost of purchasing. There were 104 data points for the regression, and the following computer output was generated:

Intercept	$9,344
Slope	8.30
Coefficient of correlation	0.86
Standard error	$220

The activity driver used was the number of purchase orders.

Required:

1. What is the cost formula?
2. Using the cost formula, predict the cost of purchasing if 88 orders are processed. (Round your answer to the nearest dollar.)
3. What percentage of the variability in purchasing cost is explained by the number of purchasing orders? Do you think the equation will predict well? Why or why not?

OBJECTIVE 6

Exercise 2-20 MULTIPLE REGRESSION

SERVICE

Horvath Bakery was started five years ago by Zoë Horvath, who was known for her breads, sweet rolls, and personalized cakes. She had kept her accounting system simple, believing that she had a good intuitive handle on costs. She had been using the following formula to describe her monthly overhead costs:

$$\text{Overhead cost} = \$7{,}800 + \$7.50\ (\text{direct labour hours})$$

For breads and sweet rolls that were available in the bakery case each day, she applied a standard pricing system. For special orders, however, Zoë needed her cost formula to help her come up with an estimated cost for the personalized cake or wedding cake. To that cost, she applied a markup percentage.

Lately, however, the increase in the variety of orders and the elaborateness of the wedding cakes made her wonder if a more sophisticated view of costs would help her in planning, budgeting, and pricing.

After some late night discussions with her workers, Zoë determined that her expansion into wedding cakes and gift baskets had made special orders a more complex operation. The various shapes of the wedding cake tiers had required her to invest in different-sized cake pans, as well as decorating tips for icing. The different icing patterns and elaborate designs took much more time for icing, as well. In addition, while a five-year-old's birthday cake just requires that the child's name and (possibly) the superhero's name be spelled correctly, a wedding cake is a once-in-a-lifetime item that must achieve perfection. (Zoë hated to use the term "bridezilla" but. . . .) Gift baskets required her to stock baskets, cellophane, and bows. Then when an order came in, a worker had to stop baking to arrange the muffins and breads artfully in the basket, wrap it, and tie the bow. While it seemed simple enough, this took time and thought. Thus, the number of direct labour hours was still an important variable, but so were the number of wedding cakes and gift baskets. Zoë rummaged through her college textbooks and found information on regression. Then, with help from one of her computer savvy workers, she ran multiple regression tables for the past 24 months of data for three independent variables: number of direct labour hours, the number of wedding cakes, and the number of gift baskets. The following printout was obtained:

Parameter	Estimate	*t* for H_o Parameter = 0	*Pr* > *t*	Standard Error of Parameter
Intercept	1,980	93.00	0.0001	264.00
Number of direct labour hours	2.56	3.60	0.0050	0.89
Number of wedding cakes	67.40	5.58	0.0050	3.19
Number of gift baskets	2.20	2.96	0.0250	0.75
$R^2 = 0.92$				
Observations: 24				

Required:

1. Write out the cost equation for Horvath Bakery's monthly overhead cost.
2. Suppose that next month the bakery expects to have 550 direct labour hours, 35 wedding cakes, and 20 gift baskets. What is the expected overhead? (Round to the nearest dollar.)

Exercise 2-21 MULTIPLE REGRESSION

OBJECTIVE 6

SERVICE

Wyle and Partners, a regional accounting firm, performs yearly audits on a number of different for-profit and not-for-profit entities. Two years ago, Callie Egbert, Wyle's partner in charge of operations, became concerned about the amount of audit time required by not-for-profit entities. So, she instituted a series of training programs focusing on the auditing of not-for-profit entities. Now she wanted to see if the training worked. So she ran a multiple regression on 18 months of data for Wyle for three variables: the total monthly cost of audit professional time, the number of not-for-profit audits, and the hours of training in the audit of not-for-profit entities. The following printout was obtained:

Parameter	Estimate	*t* for H_o Parameter = 0	*Pr* > *t*	Standard Error of Parameter
Intercept	378,880	70.00	0.0001	150.00
Number of not-for-profit audits	676	3.60	0.0050	23.45
Hours by training	−32.50	−1.96	0.0250	5.13

$R^2 = 0.79$

Observations: 18

Required:

1. Write out the cost equation for Wyle's audit professional time.
2. If Wyle expects to have 12 audits of not-for-profits next month and expects that audit professionals will have a total of 220 hours of not-for-profit training, what is the anticipated cost of professional time?
3. Are the hours spent auditing not-for-profit entities positively or negatively correlated with audit professional costs? Is percentage of experienced team members positively or negatively correlated with audit professional cost?

Exercise 2-22 LEARNING CURVE

OBJECTIVE 7

SERVICE

Bordner Company manufactures HVAC (heating, ventilation, and air conditioning) systems for commercial buildings. For each new design, Bordner faces a 90 percent learning rate. On average, the first unit of a new design takes 600 hours. Direct labour is paid $25 per hour.

Required:

1. Set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, and cumulative total time in hours. Show results by row for total production of one unit, two units, four units, eight units, and sixteen units. (Round hour answers to two significant digits.)
2. What is the total labour cost if Bordner makes the following number of units: one; four; sixteen? What is the average cost per system for the following number of systems: one, four, sixteen? (Round your answers to the nearest dollar.)
3. Using the logarithmic function, set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, cumulative total time in hours, and the time for the last unit. Show results by row for each of units one through eight. (Round answers to two significant digits.)

Exercise 2-23 LEARNING CURVE

OBJECTIVE 7

SERVICE

Sharon Glessing, controller for Janson Company, has noticed that the company faces a 75 percent learning rate for its specialty design line. In planning the cost of the latest design, Sharon assumed that the first set of units would take 1,000 direct labour hours. She decided to use this information in budgeting for the cost of the total project, which would involve the manufacture of 16 sets. Direct labour is paid $40 per hour.

Required:

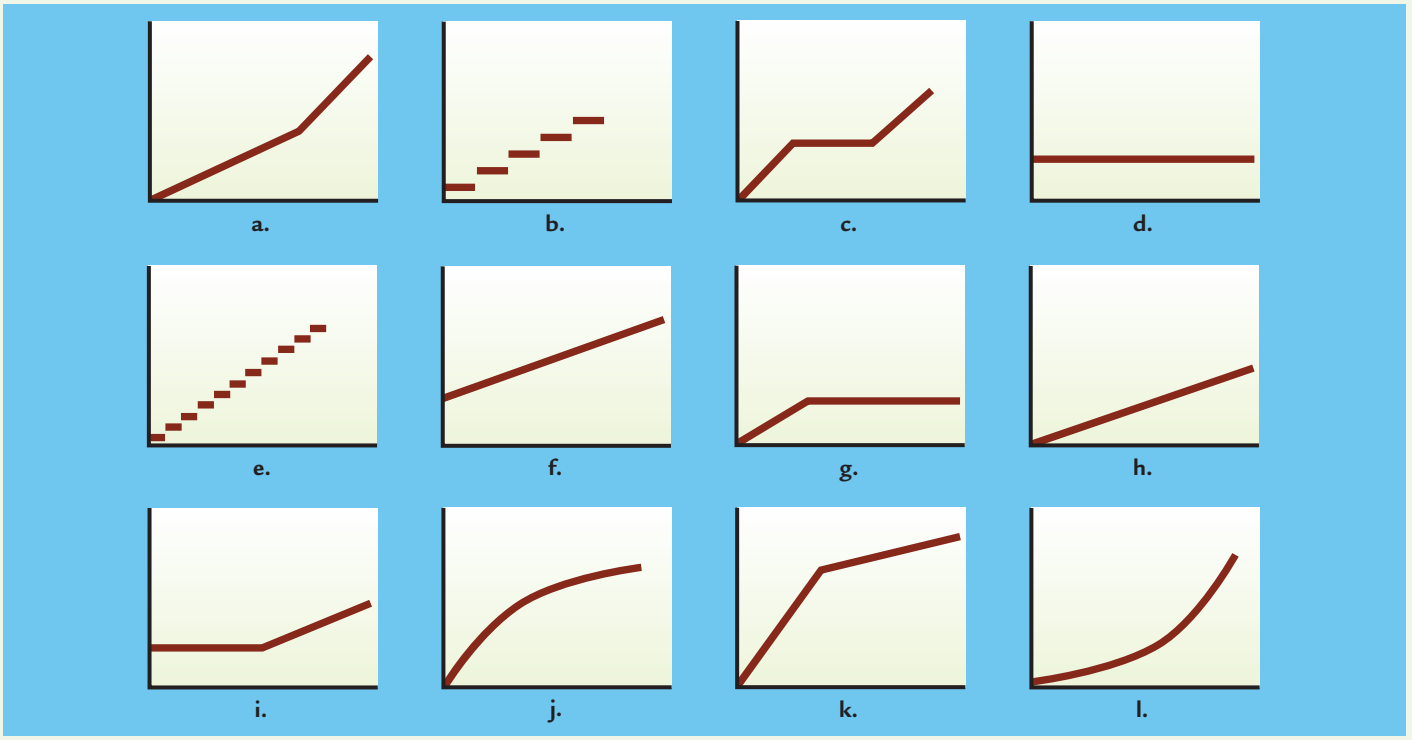
1. Set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, and cumulative total time in hours. Show results by row for total production of one unit, two units, four units, eight units, and sixteen units. (Round hour answers to two significant digits.)
2. What is the total labour cost if Janson Company makes eight sets? Sixteen sets? (Round your answers to the nearest dollar.)
3. Using the logarithmic function, set up a table with columns showing the cumulative number of units, cumulative average time per unit in hours, cumulative total time in hours, and the time for the last unit. Show results by row for each of unit sets one through eight. (Round hour answers to two significant digits.) What is the direct labour cost for the eighth set?

OBJECTIVE 1 2

SERVICE

Exercise 2-24 COST BEHAVIOUR PATTERNS

The graphs below represent cost behaviour patterns that might occur in a company's cost structure. The vertical axis represents total cost, and the horizontal axis represents activity output.



Required:

For each of the following situations, choose the graph from the group a–l that best illustrates the cost pattern involved. Also, for each situation, identify the driver that measures activity output.

1. The cost of power when a fixed fee of $500 per month is charged plus an additional charge of $0.12 per kilowatt-hour used.
2. Commissions paid to sales representatives. Commissions are paid at the rate of 5 percent of sales made up to total annual sales of $500,000, and 7 percent of sales above $500,000.
3. A part purchased from an outside supplier costs $12 per part for the first 3,000 parts and $10 per part for all parts purchased in excess of 3,000 units.
4. The cost of surgical gloves, which are purchased in increments of 100 units (gloves come in boxes of 100 pairs).
5. The cost of tuition at a local university that charges $250 per credit hour up to 15 credit hours. Hours taken in excess of 15 are free.

6. The cost of tuition at another university that charges $4,500 per semester for any course load ranging from 12 to 16 credit hours. Students taking fewer than 12 credit hours are charged $375 per credit hour. Students taking more than 16 credit hours are charged $4,500 plus $300 per credit hour in excess of 16.
7. A beauty shop's purchase of soaking solution to remove artificial nails. Each jar of solution can soak off approximately 50 nails before losing its effectiveness.
8. Purchase of diagnostics equipment by a company for inspection of incoming orders.
9. Use of disposable gowns by patients in a hospital.
10. Cost of labour at a local fast-food restaurant. Three employees are always on duty during working hours; more employees can be called in during periods of heavy demand to work on an "as-needed" basis.
11. A manufacturer found that the maintenance cost of its heavy machinery was tied to the age of the equipment. Experience indicated that the maintenance cost increased at an increasing rate as the equipment aged.

Problems

Problem 2-25 COST BEHAVIOUR, RESOURCE USAGE, EXCESS CAPACITY

OBJECTIVE ➤ 1 2

Rolertyme Company manufactures roller skates. With the exception of the rollers, all parts of the skates are produced internally. Neeta Booth, president of Rolertyme, has decided to make the rollers instead of buying them from external suppliers. The company needs 100,000 sets per year (currently it pays $1.90 per set of rollers).

The rollers can be produced using an available area within the plant. However, equipment for production of the rollers will need to be leased ($30,000 per year lease payment). Additionally, it will cost $0.50 per machine hour for power, oil, and other operating expenses. The equipment will provide 60,000 machine hours per year. Direct material costs will average $0.75 per set, and direct labour will average $0.25 per set. Since only one type of roller will be produced, no additional demands will be made on the setup activity. Other overhead activities (besides machining and setups), however, will be affected. The company's cost management system provides the following information about the current status of the overhead activities that will be affected. (The supply and demand figures do not include the effect of roller production on these activities.) The lumpy quantity indicates how much capacity must be purchased should any expansion of activity supply be needed. The purchase price is the cost of acquiring the capacity represented by the lumpy quantity. This price also represents the cost of current spending on existing activity supply (for each block of activity).

Activity Price	Cost Driver	Supply	Usage	Lumpy Quantity	Purchase
Purchasing	Orders	25,000	23,000	5,000	$25,000
Inspection	Hours	10,000	9,000	2,000	30,000
Materials handling	Moves	4,500	4,300	500	15,000

Production of rollers will place the following demands on the overhead activities:

Activity	Resource Demands
Machining	50,000 machine hours
Purchasing	2,000 purchase orders (associated with raw materials used to make the rollers)
Inspection	750 inspection hours
Materials handling	500 moves

Producing the rollers also means that the purchase of outside rollers will cease. Thus, purchase orders associated with the outside acquisition of rollers will drop by 5,000. Similarly, the moves for the handling of incoming orders will decrease by 200. The company has not inspected the rollers purchased from outside suppliers.

Required:

1. Classify all resources associated with the production of rollers as flexible resources and committed resources. Label each committed resource as a short- or long-term commitment. How should we describe the cost behaviour of these short- and long-term resource commitments? Explain.
2. Calculate the total annual resource spending (for all activities except for setups) that the company will incur after production of the rollers begins. Break this cost into fixed and variable activity costs. In calculating these figures, assume that the company will spend no more than necessary. What is the effect on resource spending caused by production of the rollers?
3. Refer to Requirement 2. For each activity, break down the cost of activity supplied into the cost of activity output and the cost of unused activity.

OBJECTIVE 1 3

SERVICE

Problem 2-26 COST BEHAVIOUR, HIGH-LOW METHOD, PRICING DECISION

St. Teresa's Medical Centre (STMC) offers a number of specialized medical services, including neuroscience, cardiology, and oncology. STMC's strong reputation for quality medical care has allowed it to branch out into other services. It is now ready to expand its orthopedic services and has just added a free-standing orthopedic clinic offering a full range of outpatient, surgical, and physical therapy services. The cost of the orthopedic facility is depreciated on a straight-line basis. All equipment within the facility is leased.

Since the clinic had no experience with in-patient orthopedic services (for patients recovering from hip and knee replacements, for example), it decided to operate the orthopedic centre for two months before determining how much to charge per patient day on an ongoing basis. As a temporary measure, the clinic adopted a patient-day charge of $190, an amount equal to the fees charged by a hospital specializing in orthopedic care in a nearby city.

This initial per-day charge was quoted to patients entering the orthopedic centre during the first two months with assurances that if the actual operating costs of the new centre justified it, the charge could be less. In no case would the charges be more. A temporary policy of billing after 60 days was adopted so that any adjustments could be made.

The orthopedic centre opened on January 1. During January, the centre had 4,200 patient days of activity. During February, the activity was 4,500 patient days. Costs for these two levels of activity output are as follows:

	4,200 Patient Days	4,500 Patient Days
Salaries, nurses	$ 55,000	$ 55,000
Aides	32,000	32,000
Pharmacy	235,700	251,300
Laboratory	120,300	127,200
Depreciation	25,000	25,000
Laundry	20,160	21,600
Administration	27,000	27,000
Lease (equipment)	36,000	36,000

Required:

1. Classify each cost as fixed, variable, or mixed, using patient days as the activity driver.
2. Use the high-low method to separate the mixed costs into fixed and variable.
3. The administrator of the orthopedic centre estimated that the centre will average 4,300 patient days per month. If the centre is to be operated as a nonprofit organization, how much will it need to charge per patient day? How much of this charge is variable? How much is fixed?
4. Suppose the orthopedic centre averages 4,800 patient days per month. How much would need to be charged per patient day for the centre to cover its costs? Explain why the charge per patient day decreased as the activity output increased.

Problem 2-27 HIGH-LOW METHOD, METHOD OF LEAST SQUARES

OBJECTIVE ➤ 2 3 4

SERVICE

PriceCut, a discount store, has gathered data on its overhead activities and associated costs for the past 10 months. Adrienne Sanjay, a member of the controller's department, believes that overhead activities and costs should be classified into groups that have the same driver. She has decided that unloading incoming goods, counting goods, and inspecting goods can be grouped together as a more general receiving activity, since these three activities are all driven by the number of purchase orders. The following 10 months of data have been gathered for the receiving activity:

Month	Purchase Orders	Receiving Cost
1	1,000	$18,600
2	700	14,000
3	1,500	28,000
4	1,200	17,500
5	1,300	25,000
6	1,100	21,000
7	1,600	28,000
8	1,400	24,000
9	1,700	26,000
10	900	16,000

Required:

1. Prepare a scattergraph, plotting the receiving costs against the number of purchase orders. Use the vertical axis for costs and the horizontal axis for orders.
2. Select two points that make the best fit, and compute a cost formula for receiving costs.
3. Using the high-low method, prepare a cost formula for the receiving activity.
4. Using the method of least squares, prepare a cost formula for the receiving activity. What is the coefficient of determination?

Problem 2-28 COST FORMULAS, SINGLE AND MULTIPLE ACTIVITY DRIVERS, COEFFICIENT OF CORRELATION

OBJECTIVE ➤ 1 3 4 6

Kimball Company has developed the following cost formulas:

Material usage:

$$Y_m = \$80X;\ r = 0.95$$

Labour usage (direct): $Y_l = \$20X;\ r = 0.96$

Overhead activity: $Y_o = \$350{,}000 + \$100X;\ r = 0.75$

Selling activity: $Y_s = \$50{,}000 + \$10X;\ r = 0.93$

where

$$X = \text{Direct labour hours}$$

The company has a policy of producing on demand and keeps very little, if any, finished goods inventory (thus, units produced equals units sold). Each unit uses one direct labour hour for production.

The president of Kimball Company has recently implemented a policy that any special orders will be accepted if they cover the costs that the orders cause. This policy was implemented because Kimball's industry is in a recession and the company is producing well below capacity (and expects to continue doing so for the coming year). The president is willing to accept orders that minimally cover their variable costs so that the company can keep its employees and avoid layoffs. Also, any orders above variable costs will increase overall profitability of the company.

Required:

1. Compute the total unit variable cost. Suppose that Kimball has an opportunity to accept an order for 20,000 units at $220 per unit. Should Kimball accept the order? (The order would not displace any of Kimball's regular orders.)
2. Explain the significance of the coefficient of correlation measures for the cost formulas. Did these measures have a bearing on your answer in Requirement 1? Should they have a bearing? Why or why not?
3. Suppose that a multiple regression equation is developed for overhead costs: $Y = \$100{,}000 + \$100X_1 + \$5{,}000X_2 + \$300X_3$, where X_1 = direct labour hours, X_2 = number of setups, and X_3 = engineering hours. The coefficient of determination for the equation is 0.94. Assume that the order of 20,000 units requires 12 setups and 600 engineering hours. Given this new information, should the company accept the special order referred to in Requirement 1? Is there any other information about cost behaviour that you would like to have? Explain.

OBJECTIVE 3 4 6

SERVICE

Problem 2-29 SCATTERPLOT, HIGH-LOW METHOD, REGRESSION

The management of Nirvana Company has decided to develop cost formulas for its major overhead activities. Nirvana's power costs are significant. Cost analysts have decided that power costs are mixed; thus, they must be broken into their fixed and variable elements so that the cost behaviour of the power usage activity can be properly described. Hours of operation have been selected as the activity driver for power costs. The following data for the past eight quarters have been collected:

Quarter	Hours of Operation	Power Cost
1	20,000	$26,000
2	25,000	38,000
3	30,000	42,500
4	22,000	35,000
5	21,000	34,000
6	18,000	31,400
7	24,000	36,000
8	28,000	42,000

Required:

1. Prepare a scattergraph by plotting power costs against hours of operation. Does the scattergraph show a linear relationship between hours and power cost?
2. Using the high and low points, compute a power cost formula.
3. Use the method of least squares to compute a power cost formula. Evaluate the coefficient of determination.
4. Rerun the regression and drop the point (20,000; $26,000) as an outlier. Compare the results from this regression to those for the regression in Requirement 3. Which is better?

OBJECTIVE 1 3 4 6

SERVICE

Problem 2-30 METHOD OF LEAST SQUARES

DeMarco Company is developing a cost formula for its packing activity. Discussion with the workers in the Packing Department has revealed that packing costs are associated with the number of customer orders, the size of the orders, and the relative fragility of the items (more fragile items must be specially wrapped in bubble wrap and Styrofoam). Data for the past 20 months have been gathered:

Month	Packing Cost	Number of Orders	Weight of Orders	Number of Fragile Items
1	$ 45,000	11,200	24,640	1,120
2	58,000	14,000	31,220	1,400
3	39,000	10,500	18,000	1,000

Month	Packing Cost	Number of Orders	Weight of Orders	Number of Fragile Items
4	$ 35,600	9,000	19,350	850
5	90,000	21,000	46,200	4,000
6	126,000	31,000	64,000	5,500
7	90,600	20,000	60,000	1,800
8	63,000	15,000	40,000	750
9	79,000	16,000	59,000	1,500
10	155,000	40,000	88,000	2,500
11	450,000	113,500	249,700	11,800
12	640,000	150,000	390,000	14,000
13	41,000	10,000	23,000	900
14	54,000	14,000	29,400	890
15	58,000	15,000	30,000	1,500
16	58,090	14,500	31,900	1,340
17	80,110	18,000	50,000	3,000
18	123,000	30,000	75,000	2,000
19	108,000	27,000	63,450	1,900
20	76,000	18,000	41,400	1,430

Required:

1. Using the method of least squares, run a regression using the number of orders as the independent variable.
2. Run a multiple regression using three independent variables: the number of orders, the weight of orders, and the number of fragile items. Which regression equation is better? Why?
3. Predict the total packing cost for 25,000 orders, weighing 40,000 kilograms, with 4,000 fragile items. Prepare a 99 percent confidence interval for this estimate of total packing cost.
4. How much would the cost estimated for Requirement 3 change if the 25,000 orders weighed 40,000 kilograms, but only 2,000 were fragile items?

Problem 2-31 HIGH-LOW METHOD, SCATTERPLOT, REGRESSION

OBJECTIVE 2 3 4 6

SERVICE

Sault Regional Hospital has collected data on all of its activities for the past 16 months. Data for cardiac nursing care follow:

	Y Cost	X Hours of Nursing Care
May 2012	$59,600	1,400
June 2012	57,150	1,350
July 2012	61,110	1,460
August 2012	65,800	1,600
September 2012	69,500	1,700
October 2012	64,250	1,550
November 2012	52,000	1,200
December 2012	66,000	1,600
January 2013	83,000	1,800
February 2013	66,550	1,330
March 2013	79,500	1,700
April 2013	76,000	1,600
May 2013	68,500	1,400
June 2013	73,150	1,550
July 2013	73,175	1,505
August 2013	66,150	1,290

Required:

1. Using the high-low method, calculate the variable rate per hour and the fixed cost for the nursing care activity.
2. Run a regression on the data, using hours of nursing care as the independent variable. Predict cost for the cardiac nursing care for September 2013, if 1,400 hours of nursing care are forecast.
3. Upon looking into the events that happened at the end of 2012, you find that the cardiology ward bought a cardiac-monitoring machine for the nursing station. Administrators also decided to add a new supervisory position for the evening shift. Monthly depreciation on the monitor and the salary of the new supervisor together total $10,000. Now, run two regression equations, one for the observations from 2012 and the second using only the observations for the eight months in 2013. Discuss your findings. What is your predicted cost of the cardiac nursing care activity for September 2013?

OBJECTIVE 1 3 4 6

SERVICE

Problem 2-32 COMPARISON OF REGRESSION EQUATIONS

Friendly Bank is attempting to determine the cost behaviour of its small business lending operations. One of the major activities is the application activity. Two possible activity drivers have been mentioned: application hours (number of hours to complete the application) and number of applications. The bank controller has accumulated the following data for the setup activity:

Month	Application Costs	Application Hours	Number of Applications
February	$ 7,700	2,000	70
March	7,650	2,100	50
April	10,052	3,000	50
May	9,400	2,700	60
June	9,584	3,000	20
July	8,480	2,500	40
August	8,550	2,400	60
September	9,735	2,900	50
October	10,500	3,000	90

Required:

1. Estimate a regression equation with application hours as the activity driver and the only independent variable. If the bank forecasts 2,600 application hours for the next month, what will be the budgeted application cost?
2. Estimate a regression equation with number of applications as the activity driver and the only independent variable. If the bank forecasts 80 applications for the next month, what will be the budgeted application cost?
3. Which of the two regression equations do you think does a better job of predicting application costs? Explain.
4. Run a multiple regression to determine the cost equation using both activity drivers. What are the budgeted application costs for 2,600 application hours and 80 applications?

OBJECTIVE 2 4 6

Problem 2-33 MULTIPLE REGRESSION, CONFIDENCE INTERVALS, RELIABILITY OF COST FORMULAS

Ivan Ivanovich, controller, has been given the charge to implement an advanced cost management system. As part of this process, he needs to identify activity drivers for the activities of the firm. During the past four months, Ivan has spent considerable

effort identifying activities, their associated costs, and possible drivers for the activities' costs.

Initially, Ivan made his selections based on his own judgment using his experience and input from employees who perform the activities. Later, he used regression analysis to confirm his judgment. Ivan prefers to use one driver per activity, provided that an R^2 of at least 80 percent can be produced. Otherwise, multiple drivers will be used, based on evidence provided by multiple regression analysis. For example, the activity of inspecting finished goods produced an R^2 of less than 80 percent for any single activity driver. Ivan believes, however, that a satisfactory cost formula can be developed using two activity drivers: the number of batches and the number of inspection hours. Data collected for a 14-month period are as follows:

Inspection Costs	Hours of Inspection	Number of Batches
$17,689	100	10
18,350	120	20
13,125	60	15
28,000	320	30
30,560	240	25
31,755	200	40
40,750	280	35
29,500	230	22
47,570	350	50
36,740	270	45
43,500	350	38
26,780	200	18
28,500	140	28
17,000	160	14

Required:

1. Calculate the cost formula for inspection costs using the two drivers, inspection hours and number of batches. Are both activity drivers useful? What does the R^2 indicate about the formula?
2. Using the formula developed in Requirement 1, calculate the inspection cost when 300 inspection hours are used and 30 batches are produced.

Problem 2-34 LEARNING CURVE

OBJECTIVE 7

Harriman Industries manufactures engines for the aerospace industry. It has completed manufacturing the first unit of the new ZX-9 engine design. Management believes that the 1,000 labour hours required to complete this unit are reasonable and is prepared to go forward with the manufacture of additional units. An 80 percent cumulative average-time learning curve model for direct labour hours is assumed to be valid. Data on costs are as follows:

Direct materials	$10,500
Direct labour	$30 per direct labour hour
Variable manufacturing overhead	$40 per direct labour hour

Required:

1. Set up a table with columns for cumulative number of units, cumulative average time per unit in hours, cumulative total time in hours, and individual unit time for the nth unit in hours. Complete the table for 1, 2, 4, 8, 16, and 32 units. (Use the logarithmic equation to get the individual unit time.)
2. What are the total variable costs of producing 1, 2, 4, 8, 16, and 32 units? What is the variable cost per unit for 1, 2, 4, 8, 16, and 32 units?

OBJECTIVE 7

SERVICE

Problem 2-35 LEARNING CURVE

Thames Assurance Company sells a variety of life and health insurance products. Recently, Thames developed a long-term care policy for sale to members of university and college alumni associations. Thames estimated that the sale and service of this type of policy would be subject to a 90 percent cumulative average-time learning curve model. Each unit consists of 350 policies sold. The first unit is estimated to take 1,000 hours to sell and service.

Required:

1. Set up a table with columns for cumulative number of units, individual unit time for the *n*th unit in hours, cumulative total time in hours, and cumulative average time per unit in hours. Complete the table for 1, 2, 4, 8, 16, and 32 units.
2. Suppose that Thames revises its assumption to an 80 percent learning curve. How will this affect the amount of time needed to sell and service eight units? How do you suppose that Thames estimates the percent learning rate?

CMA Problem

OBJECTIVE 2 3 4

CMA Problem 2-1 SIMPLE AND MULTIPLE REGRESSION, EVALUATING RELIABILITY OF AN EQUATION*

The Lockit Company manufactures doorknobs for residential homes and apartments. Lockit is considering the use of simple (single-driver) and multiple regression analyses to forecast annual sales because previous forecasts have been inaccurate. The new sales forecast will be used to initiate the budgeting process and to identify more completely the underlying process that generates sales.

Larry Husky, the controller of Lockit, has considered many possible independent variables and equations to predict sales and has narrowed his choices to four equations. Husky used annual observations from 20 prior years to estimate each of the four equations.

Following are definitions of the variables used in the four equations and a statistical summary of these equations:

Statistical Summary of Four Equations

Equation	Dependent Variable	Independent Variable(s)	Intercept	Independent Variable (Rate)	Standard Error	R_2	*t*-Value
1	S_t	S_{t-1}	$ 500,000	$ 1.10	$500,000	0.94	5.50
2	S_t	G_t	1,000,000	0.00001	510,000	0.90	10.00
3	S_t	G_{t-1}	900,000	0.000012	520,000	0.81	5.00
4	S_t		600,000		490,000	0.96	
		N_{t-1}		10.00			4.00
		G_t		0.000002			1.50
		G_{t-1}		0.000003			3.00

S_t = Forecasted sales in dollars for Lockit in period t
S_{t-1} = Actual sales in dollars for Lockit in period $t - 1$
G_t = Forecasted Canadian gross domestic product in period t
G_{t-1} = Actual Canadian gross domestic product in period $t - 1$
N_{t-1} = Lockit's net income in period $t - 1$

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Required:

1. Write Equations 2 and 4 in the form $Y = a + bx$.
2. If actual sales are $1,500,000 in 2012, what would be the forecasted sales for Lockit in 2013?
3. Explain why Husky might prefer Equation 3 to Equation 2.
4. Explain the advantages and disadvantages of using Equation 4 to forecast sales.

(CMA adapted)

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

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After studying this chapter, you should be able to:

1. Determine the number of units and amount of sales revenue needed to break even and to earn a target profit.
2. Determine the number of units and sales revenue needed to earn an after-tax target profit.
3. Apply cost-volume-profit analysis in a multiple-product setting.
4. Prepare a profit-volume graph and a cost-volume-profit graph, and explain the meaning of each.
5. Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.
6. Discuss the impact of non-unit cost drivers on cost-volume-profit analysis.

CHAPTER

3 Cost-Volume-Profit Analysis

Cost-volume-profit analysis (CVP analysis) is a powerful tool for planning and decision making. Because CVP analysis emphasizes the interrelationships of costs, quantity sold, and price, it brings together all of the financial information of the firm. CVP analysis can be a valuable tool in identifying the extent and magnitude of the economic trouble a company is facing and helping pinpoint the necessary solution. The severe recession beginning in 2008 led a number of companies to concentrate on breaking even.

For example, the **Mayo Clinic** announced that it had broken even for 2008 despite missing its revenue goal by $133 million.[1] The airline industry uses cost-volume-profit analysis in decisions ranging from whether to add another flight to whether to even start a new airline. Lower fuel costs and reduced

[1] Sea Stachura, "Mayo Clinic Breaks Even in 2008," Minnesota Public Radio, March 12, 2009. http://minnesota.publicradio.org/display/web/2009/03/12/mayobudget/?refid=0, accessed March 15, 2009.

capacity led **Delta Air Lines** to estimate it would break even in the first quarter of 2009.[2] Other airlines faced different market conditions and a less favourable outcome. **Air India** and **Jet Airways** were hurt by the weak rupee (Indian currency). The unfavourable currency exchange rate meant that costs the airlines must pay for fuel (denominated in dollars) would have to be offset by revenues that are denominated in rupees. The fall of the value of the rupee increased costs such that **SpiceJet** and Jet Airways faced failure to break even.[3]

CVP analysis can address many issues, such as the number of units that must be sold to break even, the impact a given reduction in fixed costs can have on the break-even point, and the impact an increase in price can have on profit. Additionally, CVP analysis allows managers to conduct sensitivity analyses by examining the impact of various price or cost levels on profit.

While this chapter deals with the mechanics and terminology of CVP analysis, your objective in studying CVP analysis is more than to learn the mechanics. CVP analysis is an integral part of financial planning and decision making. Every accountant and manager should thoroughly understand and be able to apply its concepts.

The Break-Even Point and Target Profit in Units and Sales Revenue

OBJECTIVE 1
Determine the number of units and amount of sales revenue needed to break even and to earn a target profit.

To find out how revenues, expenses, and profits behave as volume changes, it is natural to begin by finding the firm's break-even point in units sold and in sales revenue. Two frequently used approaches to finding the break-even point are the operating income approach and the contribution margin approach. We will discuss these two approaches to find the **break-even point** (the point of zero profit) and then see how each can determine the total sales revenue at break-even. The determination of units or revenue needed to achieve a target profit is a generalized case of the break-even formulas.

The first step in implementing a units-sold approach to CVP analysis is to determine just what a unit is. For manufacturing firms, the answer is obvious.

Research In Motion may define a unit as a BlackBerry device. Service firms face more varied choices. **Porter Airlines** may define a unit as a passenger mile or a one-way trip. **Canada's Wonderland** counts the number of visitor-days. The **Hospital for Sick Children** in Toronto treats many seriously ill patients from all across the province. They define services to patients in diagnostic-related groups, so that more complicated treatment is weighted more heavily than simple procedures.

The second step is to separate costs into fixed and variable components. CVP analysis focuses on the factors that change the components of profit. Because we are looking at CVP analysis in terms of units sold, we need to determine the fixed and variable components of cost and revenue with respect to units. (This assumption is relaxed when we incorporate activity-based costing into CVP analysis.) It is important to realize that CVP focuses on the firm as a whole. Therefore, *all* costs of the company—manufacturing, marketing, and administrative—are taken into account. Variable costs include *all costs* that increase as more units are sold, including direct

[2] Ann Keaton, "Delta Air Expects a Profit for '09; Keeps Order for 18 787s," *CNN Money.com*, March 10, 2009. http://money.cnn.com/news/newsfeeds/articles/djf500/200903101408DOWJONESDJONLINE000657_FORTUNE5.htm, accessed March 15, 2009.

[3] Mithun Roy, "Falling Re May Force Domestic Airlines to Revise Profit Targets," *The Economic Times*, March 3, 2009. http://economictimes.indiatimes.com/News/News-By-Industry/Transportation/Airlines–Aviation/Falling-Re-may-force-domestic-airlines-to-revise-profit-targets/articleshow/4215213.cms, accessed March 15, 2009.

materials, direct labour, variable manufacturing overhead, and variable selling and administrative costs. Similarly, fixed costs are composed of all fixed manufacturing overhead and fixed selling and administrative expenses.

Basic Concepts for CVP Analysis

The fundamental concept underlying CVP analysis is that the firm's costs can be analysed into variable and fixed costs. A useful tool for organizing the firm's costs into fixed and variable categories is the contribution-margin-based income statement. Note that **operating income** is income or profit *before* income taxes. Operating income includes only revenues and expenses from the firm's normal operations. The term **net income** is used to mean operating income minus income taxes. Cornerstone 3-1 illustrates basic CVP terms and the preparation of the contribution-margin-based income statement.

Cornerstone 3-1 shows that the contribution-margin-based operating income statement is a powerful tool for analyzing a company's projected performance. Notice that the existence of fixed costs means that sales above the estimated 10,000 units, say a 1,000-unit or 10 percent increase, would yield more than a 10 percent increase in operating income. Similarly, a 1,000-unit or 10 percent decrease would decrease operating income by more than 10 percent. This is why an understanding of fixed and variable costs is so important to managers as they examine the impact of changing sales on income.

The Equation Method for Break-Even and Target Income

Companies frequently want to know how many units must be produced and sold to break even or to earn a target income. In other words, how many units will yield the desired (at break-even, zero) profit? The basic break-even/target income equation can be easily derived from the contribution-margin-based operating income statement.

$$\text{Operating income} = \text{Sales revenues} - \text{Variable expenses} - \text{Fixed expenses}$$

This operating income equation can be expanded by expressing sales revenue and variable expenses in terms of unit dollar amounts and number of units. Thus, sales revenue equals the unit selling price times the number of units sold, and total variable costs equal the unit variable cost times the number of units sold. With these expressions, the operating income statement becomes:

$$\begin{aligned}\text{Operating income} = {} & (\text{Price} \times \text{Number of units}) - (\text{Variable cost per unit} \\ & \times \text{Number of units}) - \text{Total fixed costs}\end{aligned}$$

Finally, the equation for a target profit is put in terms of units:

$$\text{Units for a target profit} = (\text{Total fixed cost} + \text{Target income})/(\text{Price} - \text{Variable cost per unit})$$

For the special case when target income is zero, the break-even equation becomes:

$$\begin{aligned}\text{Break-even units} &= (\text{Total fixed cost} + 0)/(\text{Price} - \text{Variable cost per unit}) \\ &= \text{Total fixed cost}/(\text{Price} - \text{Variable cost per unit})\end{aligned}$$

An important advantage of the operating income statement is that all further CVP equations are derived from the contribution-margin-based income statement. As a result, any CVP problem can be solved by using this approach. Cornerstone 3-2 shows how and why to calculate the units needed to break even and to achieve a target profit.

The HOW and WHY of Basic Cost Calculations and the Contribution-Margin-Based Income Statement

CORNERSTONE 3-1

Information:

Blazin-Boards Company plans to sell 10,000 snowboards at $400 each in the coming year. Product costs include:

Direct materials per snowboard	$80
Direct labour per snowboard	$125
Variable overhead per snowboard	$15
Total fixed factory overhead	$800,000

Variable selling expense is a commission of 5 percent of price; fixed selling and administrative expense totals $400,000.

Why:

Since variable *product* cost per unit consists of variable production or manufacturing costs, the plant manager would use this data. The plant manager is responsible for making a quality product as inexpensively and efficiently as possible. Knowing that variable product cost is $220 per unit provides a starting place for seeing what process improvements might do to the unit cost.

The sales manager would be interested in the total variable cost per unit. Since this cost includes the sales commission, it reflects all of the variable costs. Sales managers can see the impact of the commissions (for which they are responsible) and can also see what impact a one-time discount might have on overall profitability.

Top management would use the unit contribution margin for budgeting to see what impact an increase or a decrease in unit sales would have on operating income. Since fixed costs stay the same when units change, the contribution margin gives important information.

Required:

1. Calculate the:
   a. Variable product cost per unit
   b. Variable selling expense per unit
   c. Total variable cost per unit
   d. Contribution margin per unit
   e. Contribution margin ratio
   f. Total fixed expense for the year
2. Prepare a contribution-margin-based income statement for Blazin-Boards Company for the coming year.
3. ***What if*** 13,000 boards could be manufactured and sold next year; how would that affect operating income? By what percent?

Solution:

1. a. $$\text{Variable product cost per unit} = \text{Direct materials} + \text{Direct labour} + \text{Variable overhead}$$
$$= \$80 + \$125 + \$15 = \$220$$

   b. $$\text{Variable selling expense per unit} = \$400 \times 0.05 = \$20$$

   c. $$\text{Variable cost per unit} = \text{Direct materials} + \text{Direct labour} + \text{Variable overhead} + \text{Variable selling expense}$$
$$= \$80 + \$125 + \$15 + \$20 = \$240$$

CORNERSTONE 3-1 *(continued)*

d. Contribution margin per unit = Price − Variable cost per unit
= $400 − $240 = $160

e. Contribution margin ratio = (Price − Variable cost per unit)/Price
= ($400 − $240)/$400 = 0.40 = 40%

OR

= (Sales − Total variable cost)/Sales
= ($4,000,000 − $2,400,000)/$4,000,000
= 0.40 = 40%

f. Total fixed expense = $800,000 + $400,000 = $1,200,000

2.

Blazin-Boards Company
Contribution-Margin-Based Operating Income Statement
For the Coming Year

	Total	Per Unit
Sales ($400 × 10,000 snowboards)	$4,000,000	$400
Total variable expense ($240 × 10,000)	2,400,000	240
Total contribution margin	1,600,000	$160
Total fixed expense	1,200,000	
Operating income	$ 400,000	

3.

Increase in sales (3,000 boards × $400)	$1,200,000
Less:	
Increase in variable cost (3,000 boards × $240)	720,000
Increase in fixed cost	0
Increase in operating income	$ 480,000

Operating income will be $480,000 higher, or $880,000 in total. This is a 120 percent ($480,000/$400,000) increase in operating income, even though the number of units sold would increase by only 30 percent. (Since fixed costs have already been covered, any increase in contribution margin goes directly to operating income.)

Contribution Margin Approach

A refinement of the equation approach is the contribution margin approach. It simply recognizes that at break-even, the total contribution margin equals the fixed expenses. The **contribution margin** is sales revenue minus total variable costs. By substituting the unit contribution margin for price minus unit variable cost in the operating income equation, and solving for the number of units, the following break-even expression is obtained:

Number of units = Fixed costs/Unit contribution margin

Recall that Cornerstone 3-1, Requirement 2, shows the income statement for the budgeted sales for the coming year for Blazin-Boards Company. The contribution margin per unit can be computed in one of two ways. One way is to divide the total

The HOW and WHY of Calculating the Units Needed to Break Even and to Achieve a Target Profit

CORNERSTONE 3-2

Information:

Blazin-Boards Company plans to sell 10,000 snowboards at $400 each in the coming year. Product costs include:

Direct materials per snowboard	$80
Direct labour per snowboard	$125
Variable overhead per snowboard	$15
Total fixed factory overhead	$800,000

Variable selling expense is a commission of 5 percent of price; fixed selling and administrative expense totals $400,000.

Why:

At the break-even point, total revenue equals total cost. Once the break-even point is reached, all fixed costs are covered and additional units add only variable costs. Thus, contribution margin earned above break-even will go toward operating profit. The target operating income is treated as fixed cost for the purpose of calculating the number of units that must be produced and sold. Knowing the break-even units gives managers an easy way to tell just when during the year the firm moves out of the red and into the black.

Required:

1. Calculate the number of units Blazin-Boards must sell to break even. Prepare a contribution-margin-based income statement for the calculated units.
2. Calculate the number of units Blazin-Boards must sell to achieve target operating income (profit) of $240,000.
3. ***What if*** Blazin-Boards wanted to achieve a target operating income of $300,000? Would the number of snowboards be larger or smaller than the number calculated in Requirement 2? Why?

Solution:

1. $$\text{Break-even units} = \text{Total fixed costs}/(\text{Price} - \text{Unit variable cost})$$
$$= \$1{,}200{,}000/(\$400 - \$240)$$
$$= 7{,}500$$

Sales (7,500 units @ $400)	$3,000,000
Less: Variable expenses	1,800,000
Contribution margin	1,200,000
Less: Fixed expenses	1,200,000
Operating income	$ 0

Indeed, selling 7,500 units does yield a zero profit.

2. $$\text{Units for } \$240{,}000 = (\text{Total fixed costs} + \text{Target profit})/(\text{Price} - \text{Unit variable cost})$$
$$= (\$1{,}200{,}000 + \$240{,}000)/(\$400 - \$240)$$
$$= 9{,}000$$

3. For a target profit of $300,000, more than 9,000 units must be sold. In fact, 9,375 units will yield this profit.

$$\text{Units for } \$300{,}000 = (\$1{,}200{,}000 + \$300{,}000)/(\$400 - \$240) = 9{,}375$$

contribution margin by the units to be sold for a result of $160 per unit ($1,600,000/10,000). A second way is to compute price minus variable cost per unit. Doing so yields the same result, $160 per unit ($400 − $240). Now, we can use the contribution margin approach to calculate the break-even number of units.

$$\begin{aligned}\text{Number of units} &= \$1{,}200{,}000/(\$400 - \$240)\\ &= \$1{,}200{,}000/\$160 \text{ per unit}\\ &= 7{,}500 \text{ units}\end{aligned}$$

Of course, the answer is identical to the one computed previously using the equation approach.

Another way to check this number of units computed in Cornerstone 3-2 is to use the break-even point. As was shown in Cornerstone 3-1, Blazin-Boards must sell 10,000 snowboards, or 2,500 more than the break-even volume of 7,500 units, to earn an operating profit of $400,000. The contribution margin per snowboard is $160. Multiplying $160 by the 2,500 snowboards *above* break-even produces the operating profit of $400,000 ($160 × 2,500). This outcome demonstrates that contribution margin per unit for each unit above break-even is equivalent to the operating profit per unit. Since the break-even point had already been computed, the number of snowboards to be sold to yield a $900,000 operating income could have been calculated by dividing the unit contribution margin into the target profit and adding the resulting amount to the break-even volume.

Suppose that Blazin-Boards sells 11,000 snowboards rather than the 10,000 budgeted. What will operating income be in that case? Since fixed costs have already been covered when 10,000 units are sold, the only costs that must be covered on the additional units are the variable costs of $240 per unit. A quicker, more direct way to calculate the new, higher operating income is to take the original operating income of $400,000 for 10,000 units sold and add the contribution margin on the additional 1,000 units, or $160,000 (1,000 × $160). Thus, the total operating income for 11,000 units sold is $560,000 ($400,000 + $160,000).

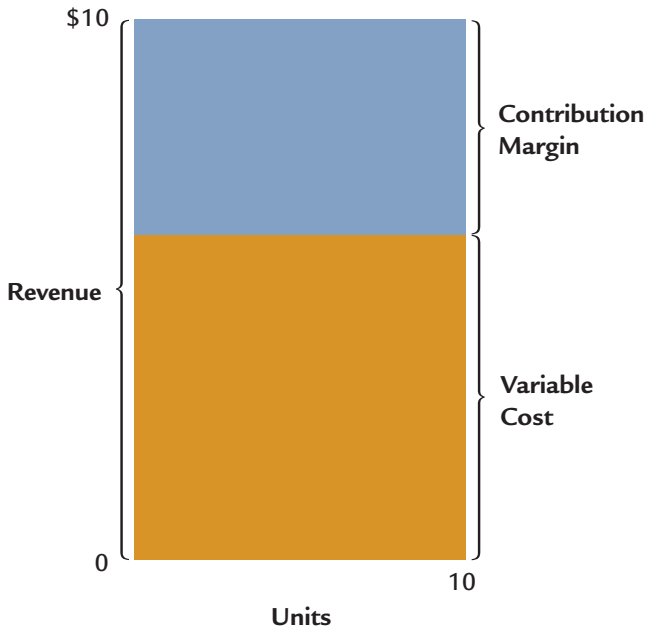
Break-Even Point and Target Income in Sales Revenue Sometimes, managers prefer to use sales revenue as the measure of sales activity instead of units sold. A units-sold measure can be converted to a sales-revenue measure simply by multiplying the unit sales price by the units sold. For example, the break-even point for Blazin-Boards Company was 7,500 snowboards. At the selling price per snowboard of $400, the break-even sales revenue is $3,000,000 ($400 × 7,500). Any answer expressed in units sold can be easily converted to an answer expressed in terms of sales revenue, if the break-even units can be easily computed. However, this is seldom the case in a multiproduct firm. Fortunately, break-even revenue can be computed directly by developing a separate formula based on total fixed costs, target profit, and the contribution margin ratio. In this case, the important variable is sales revenue, so both the revenue and the variable costs must be expressed in dollars instead of units. Sales revenue is always expressed in dollars, so measuring that variable is no problem. Let's look more closely at variable costs and see how they can be expressed in terms of sales revenue.

To express variable cost in terms of sales revenue, we compute the **variable cost ratio**, which is the proportion of each sales dollar that must be used to cover variable costs. The variable cost ratio can be computed by using either total data or unit data. Of course, the percentage of sales revenue remaining after variable costs are covered is the contribution margin ratio. The **contribution margin ratio** is the proportion of each sales dollar available to cover fixed costs and provide for profit. In Exhibit 3-1, if the variable cost ratio is 60 percent of sales, then the contribution margin must be the remaining 40 percent of sales. It makes sense that the complement of the variable cost ratio is the contribution margin ratio. After all, the proportion of the sales revenue left after variable costs are covered should be the contribution margin component.

Where do fixed costs fit in? Since the contribution margin is revenue remaining after variable costs are covered, it must be the revenue available to cover fixed costs and

Exhibit 3-1

Division of Revenue into Variable Cost and Contribution Margin



contribute to profit. In other words, we compare total fixed costs to the total contribution margin. If total fixed costs equal the contribution margin, profit is zero. (The company is at break-even.) If total fixed costs are less than the contribution margin, the company earns an operating profit equal to the excess of contribution margin over fixed costs. Finally, if total fixed costs are greater than the contribution margin, the company faces an operating loss.

Now, let's consider the **sales-revenue approach** by looking at the basic income statement.

$$\text{Operating income} = \text{Sales} - \text{Variable costs} - \text{Total fixed costs}$$
$$\text{Operating income} = \text{Sales} - (\text{Variable cost ratio} \times \text{Sales}) - \text{Total fixed costs}$$
$$\text{Operating income} = \text{Sales}\,(1 - \text{Variable cost ratio}) - \text{Total fixed costs}$$
$$\text{Operating income} = \text{Sales} \times \text{Contribution margin ratio} - \text{Total fixed costs}$$
$$\text{Sales} = (\text{Total fixed costs} + \text{Operating income})/\text{Contribution margin ratio}$$

At break-even, operating income equals zero, so the equation becomes:

$$\text{Break-even sales} = \text{Total fixed costs}/\text{Contribution margin ratio}$$

To earn a targeted operating income, sales equal the sum of the total fixed costs and target income divided by the contribution margin ratio.

What about the equation approach used in determining the break-even point in units? We can use that approach here as well. Recall that the formula for the break-even point in units is as follows:

$$\text{Break-even point in units} = \text{Total fixed costs}/(\text{Price} - \text{Unit variable cost})$$

If we multiply both sides of the above equation by price, the left-hand side will equal sales revenue at break-even.

$$\text{Break-even units} \times \text{Price} = \text{Price}\,[\text{Total fixed costs}/(\text{Price} - \text{Unit variable cost})]$$
$$\text{Break-even sales} = \text{Total fixed costs} \times [\text{Price}/(\text{Price} - \text{Unit variable cost})]$$
$$\text{Break-even sales} = \text{Total fixed costs} \times (\text{Price}/\text{Contribution margin})$$
$$\text{Break-even sales} = \text{Total fixed costs}/\text{Contribution margin ratio}$$

CORNERSTONE 3-3

The HOW and WHY of Calculating Revenue for Break-Even and for a Target Profit

Information:

Blazin-Boards Company plans to sell 10,000 snowboards at $400 each in the coming year. Unit variable cost equals $240. Total fixed costs equal $1,200,000.

Why:

Companies frequently prefer to express the break-even point in sales revenue. To do that, we recognize that total sales revenue must cover both total fixed costs and desired operating income. That is, the proportion of revenue left after variable costs are covered is what is left to cover fixed costs and income.

Required:

1. What is the contribution margin per unit? What is the contribution margin ratio?
2. Calculate the sales revenue needed to break even.
3. Calculate the sales revenue needed to achieve a target operating profit of $240,000.
4. ***What if*** Blazin-Boards had target operating income (profit) of $350,000? Would sales revenue be larger or smaller than the one calculated in Requirement 3? Why? By how much?

Solution:

1. $$\text{Contribution margin per unit} = \text{Price} - \text{Unit variable cost}$$
$$= \$400 - \$240 = \$160$$
$$\text{Contribution margin ratio} = \$160/\$400 = 0.40, \text{ or } 40\%$$
2. $$\text{Break-even sales revenue} = \text{Total fixed cost}/\text{Contribution margin ratio}$$
$$= \$1,200,000/0.40 = \$3,000,000$$
3. $$\text{Target sales revenue} = (\text{Total fixed cost} + \text{Target profit})/\text{Contribution margin ratio}$$
$$= (\$1,200,000 + \$240,000)/0.40 = \$3,600,000$$
4. Target profit of $350,000 is larger than $240,000, so the sales revenue needed would be larger by $275,000.
$$\text{New target sales revenue} = (\$1,200,000 + \$350,000)/0.40 = \$3,875,000$$
$$\text{Increase in sales revenue} = \$3,875,000 - \$3,600,000 = \$275,000$$

Just as target income was added to total fixed costs in determining unit sales, target operating income is added to total fixed costs when calculating the sales revenue needed for a target operating income. Cornerstone 3-3 illustrates the calculation of break-even sales revenue and sales revenue needed to achieve a target operating profit for Blazin-Boards Company.

In general, assuming that fixed costs remain unchanged, the contribution margin ratio can be used to find the profit impact of a change in sales revenue. To obtain the total change in operating profits from a change in revenue, simply multiply the contribution margin ratio by the change in sales. For example, if sales revenue is $4,000,000 instead of $4,600,000, how will the expected profits be affected? A decrease in sales revenue of $600,000 will cause a decrease in profits of $240,000 ($0.40 \times \$600,000$).

Targeted Income as a Percent of Sales Revenue Assume that BlazinBoards Company wants to know the number of snowboards that must be sold in order to earn a profit equal to 15 percent of sales revenue. Sales revenue is selling price multiplied by the quantity sold. Thus, the targeted operating income is 15 percent of selling price times quantity. Using the operating income approach (which is simpler in this case), we obtain the following:

$$\begin{aligned} 0.15(\$400)(\text{Units}) &= (\$400)(\text{Units}) - (\$240)(\text{Units}) - \$1{,}200{,}000 \\ (\$60)(\text{Units}) &= (\$160)(\text{Units}) - \$1{,}200{,}000 \\ \$100(\text{Units}) &= \$1{,}200{,}000 \\ \text{Units} &= 12{,}000 \end{aligned}$$

Does a volume of 12,000 snowboards achieve an operating profit equal to 15 percent of sales revenue? For 12,000 snowboards, the total revenue is $4,800,000 ($400 × 12,000). The operating profit can be computed without preparing a formal income statement. Remember that above break-even, the contribution margin per unit is the operating profit per unit. The break-even volume is 7,500 snowboards. If 12,000 snowboards are sold, then 4,500 (12,000 − 7,500) snowboards above the break-even point are sold. The before-tax profit, therefore, is $720,000 ($160 × 4,500), which is 15 percent of sales ($720,000/$4,800,000).

Comparison of the Break-Even Point in Units and Sales Revenue

For a single-product setting, converting the break-even point in units answer to a sales-revenue answer is simply a matter of multiplying the unit sales price by the units sold. Then why bother with a separate formula for the sales-revenue approach? For a single-product setting, neither approach has any real advantage over the other. Both offer much the same level of conceptual and computational difficulty.

However, in a multiple-product setting, CVP analysis is more complex, and the sales-revenue approach is significantly easier. This approach maintains essentially the same computational requirements found in the single-product setting, whereas the units-sold approach becomes more difficult. Even though the conceptual complexity of CVP analysis does increase with multiple products, the operation is reasonably straightforward.

After-Tax Profit Targets

OBJECTIVE 2
Determine the number of units and sales revenue needed to earn an after-tax target profit.

Income taxes are generally calculated as a percentage of income. When calculating the break-even point, income taxes play no role because the taxes paid on zero income are zero. However, when the company needs to know how many units to sell to earn a particular net income, some additional consideration is needed. Recall that net income is operating income minus income taxes and that our targeted income figure was expressed in before-tax terms. As a result, when the income target is expressed as net income, we must add back the income taxes to get operating income. Therefore, to use either the equation method or the contribution margin approach, the after-tax profit target must first be converted to a before-tax profit target.

In general, taxes are computed as a percentage of income. The after-tax profit, or net income, is computed by subtracting income taxes from the operating income (or before-tax profit).

$$\begin{aligned} \text{Net income} &= \text{Operating income} - \text{Income taxes} \\ \text{Net income} &= \text{Operating income} - (\text{Tax rate} \times \text{Operating income}) \\ \text{Net income} &= \text{Operating income}\,(1 - \text{Tax rate}) \end{aligned}$$

or

$$\text{Operating income} = \text{Net income}/(1 - \text{Tax rate})$$

Thus, to convert the after-tax profit to before-tax profit, simply divide the after-tax profit by the quantity (1 − Tax rate). Cornerstone 3-4 shows how to calculate the number of units needed to achieve an after-tax profit target.

CORNERSTONE 3-4

The HOW and WHY of Calculating the Number of Units to Generate an After-Tax Target Profit

Information:

Blazin-Boards Company wants to earn $390,000 in net (after-tax) income next year. Snowboards are priced at $400 each for the coming year. Product costs include:

Direct materials per snowboard	$80
Direct labour per snowboard	$125
Variable overhead per snowboard	$15
Total fixed factory overhead	$800,000

Variable selling expense is a commission of 5 percent of price; fixed selling and administrative expense totals $400,000. Blazin-Boards has a tax rate of 35 percent.

Why:

Top management may be interested in target net income, since income taxes are a legitimate expense of the business and owners are interested in after-tax income. The accountant must first convert net income into operating income since the tax rate is a variable that is not taken into account in the break-even equation. Once the conversion is made, the break-even equation can be applied.

Required:

1. Calculate the before-tax profit needed to achieve an after-tax target of $422,500.
2. Calculate the number of boards that will yield operating income calculated in Requirement 1 above.
3. Prepare an income statement for Blazin-Boards Company for the coming year based on the number of boards computed in Requirement 2.
4. ***What if*** Blazin-Boards had a 30 percent tax rate. Would the units sold to reach a $422,500 target net income be higher or lower than the result in Requirement 2? Calculate the number of units needed.

Solution:

1. $$\begin{aligned}\text{Before-tax income} &= \text{After-tax income}/(1 - \text{Tax rate})\\ &= \$422{,}500/(1 - 0.35)\\ &= \$422{,}500/(0.65)\\ &= \$650{,}000\end{aligned}$$

2. $$\begin{aligned}\text{Number of boards} &= (\text{Total fixed cost} + \text{Target profit})/\\ &\quad (\text{Price} - \text{Variable cost per unit})\\ &= (\$1{,}200{,}000 + \$650{,}000)/(\$400 - \$240)\\ &= 11{,}563 \text{(rounded)}\end{aligned}$$

3.

Blazin-Boards Company
Income Statement
For the Coming Year

	Total	Per Unit
Sales ($400 × 11,563 snowboards)	$4,625,200	$400
Total variable expense ($240 × 11,563)	2,775,120	240
Total contribution margin	1,850,080	$160

CORNERSTONE 3-4 (continued)

	Total	Per Unit
Total fixed expense	1,200,000	
Operating income	650,080	
Less: Income taxes ($650,080 × 0.35)	227,528	
Net income*	$ 422,552	

*Note that net income is $52 higher than the target due to rounding the units up from 11,562.5 to 11,563.

4. The units would be lower than 11,563 since the lower tax rate means that a smaller operating income would be needed to yield the same target net income.

$$\begin{aligned}\text{Before-tax income} &= \text{After-tax income}/(1 - \text{Tax rate})\\ &= \$422{,}500/(1 - 0.30)\\ &= \$603{,}571 \text{(rounded)}\\ \text{Number of boards} &= (\text{Total fixed cost} + \text{Target profit})/\\ &\quad (\text{Price} - \text{Variable cost per unit})\\ &= (\$1{,}200{,}000 + \$603{,}571)/(\$400 - \$240)\\ &= 11{,}272 \text{(rounded)}\end{aligned}$$

Multiple-Product Analysis

OBJECTIVE 3
Apply cost-volume-profit analysis in a multiple-product setting.

Blazin-Boards Company has decided to offer two models of snowboards: a regular snowboard to sell for $400 and a deluxe snowboard, using graphite and designed for championship-calibre boarders, to sell for $600. The Marketing Department is convinced that 10,000 regular snowboards and 2,500 deluxe snowboards can be sold during the coming year. The controller has prepared the following projected income statement based on the sales forecast:

	Regular Snowboards	Deluxe Snowboards	Total
Sales	$4,000,000	$1,500,000	$5,500,000
Less: Variable expenses	2,400,000	750,000	3,150,000
Contribution margin	1,600,000	750,000	2,350,000
Less: Direct fixed expenses	400,000	200,000	600,000
Product margin	$1,200,000	$ 550,000	1,750,000
Less: Common fixed expenses			200,000
Operating income			$1,550,000

Note that the controller has separated direct fixed expenses from common fixed expenses. The **direct fixed expenses** are those fixed costs that can be traced to each segment and that would be avoided if the segment did not exist. Examples of direct fixed expenses include salaries of the individual segment's supervisors, any equipment that must be leased or bought just for that segment, and so on. The **common fixed expenses** are the fixed costs that are not traceable to the segments and that would remain even if one of the segments was eliminated. Corporate headquarters costs are common fixed expenses, as are the costs of the factory manager and factory landscaping.

Break-Even Point in Units and Sales Revenue for the Multiple-Product Setting

The owner of Blazin-Boards is apprehensive about adding a new product line and wants to know how many of each model must be sold to break even. If you were given the responsibility to answer this question, how would you respond?

One possible response is to use the equation we developed earlier in which fixed costs were divided by the contribution margin. However, this equation was developed for a single-product analysis. For two products, there are two unit contribution margins. The regular snowboard has a contribution margin per unit of $160 ($400 − $240), and the deluxe snowboard has one of $300 ($600 − $300). One possible solution is to apply the analysis separately to each product line. It is possible to obtain individual break-even points when income is defined as product margin. Break-even for the regular snowboard is as follows:

$$\begin{aligned}\text{Regular snowboard break-even units} &= \text{Fixed costs}/(\text{Price} - \text{Unit variable cost})\\ &= \$400{,}000/\$160\\ &= 2{,}500 \text{ units}\end{aligned}$$

Break-even for the deluxe snowboard can be computed as well.

$$\begin{aligned}\text{Deluxe snowboard break-even units} &= \text{Fixed costs}/(\text{Price} - \text{Unit variable cost})\\ &= \$200{,}000/\$300\\ &= 667 \text{ units (rounded)}\end{aligned}$$

Thus, 2,500 regular snowboards and 667 deluxe snowboards must be sold to achieve a break-even product margin. But a break-even product margin covers only direct fixed costs; the common fixed costs remain to be covered. Selling these numbers of snowboards would result in a loss equal to the common fixed costs. No break-even point for the firm as a whole has yet been identified. Somehow, the common fixed costs must be factored into the analysis.

Allocating the common fixed costs to each product line before computing a break-even point may resolve this difficulty. The problem with this approach is that allocation of the common fixed costs is arbitrary. Thus, no meaningful break-even volume is readily apparent.

Another possible solution is to convert the multiple-product problem into a single-product problem. If this can be done, then all of the single-product CVP methodology can be applied directly. The key to this conversion is to identify the expected sales mix, in units, of the products being sold.

Sales Mix

Sales mix is the relative combination of products being sold by a firm. Sales mix can be measured in units sold or in proportion of revenue. For example, if Blazin-Boards plans to sell 10,000 regular snowboards and 2,500 deluxe snowboards, then the sales mix in units is 10,000:2,500. Usually, the sales mix is reduced to the smallest possible whole numbers. Thus, the relative mix 10,000:2,500 can be reduced to 100:25 and further to 4:1. That is, for every four regular snowboards sold, one deluxe snowboard is sold.

Alternatively, the sales mix can be represented by the percent of total revenue contributed by each product. In that case, the regular snowboard revenue is $4,000,000 ($400 × 10,000), and the deluxe snowboard revenue is $1,500,000 ($600 × 2,500). The regular snowboard accounts for 70 percent of total revenue, and the deluxe snowboard accounts for the remaining 30 percent (where the percentages are rounded). It may seem as though the two sales mixes are different. The sales mix in units is 4:1; that is, of every five snowboards sold, 80 percent are regular snowboards and 20 percent are deluxe snowboards. However, the revenue-based sales mix is 70 percent for the regular snowboards. There is really no difference. The sales mix in revenue takes the sales mix in units and weights it by price. Therefore, even though the underlying proportion of snowboards sold

remains 4:1, the lower priced regular snowboards are weighted less heavily when price is factored in. In the remaining discussion, we will use the sales mix expressed in units.

A number of different sales mixes can be used to define the break-even volume. For example, a sales mix of 5:1 will define a break-even point of 3,637 regular snowboards and 727 deluxe snowboards. The total contribution margin produced by this mix is \$800,020 [(\$160 × 3,637) + (\$300 × 727)]. Similarly, if 2,353 regular snowboards and 1,412 deluxe snowboards are sold (corresponding to a 5:3 sales mix), the total contribution margin is \$800,080 [(\$160 × 2,353) + (\$300 × 1,412)]. Since total fixed costs are \$800,000, both sales mixes define break-even points. Fortunately, every sales mix need not be considered. Can Blazin-Boards really expect a sales mix of 5:1 or 5:3? For every two regular snowboards sold, does Blazin-Boards expect to sell a deluxe snowboard? Or for every regular snowboard, can Blazin-Boards really sell one deluxe snowboard?

According to Blazin-Boards's marketing study, a sales mix of 4:1 can be expected. This is the ratio that should be used; the others can be ignored. The sales mix that is expected to prevail should be used for CVP analysis.

Sales Mix and CVP Analysis Defining a particular sales mix allows us to convert a multiple-product problem to a single-product CVP format. Since Blazin-Boards expects to sell four regular snowboards for every deluxe snowboard, it can define the single product it sells as a package containing four regular snowboards and one deluxe snowboard. By defining the product as a package, the multiple-product problem is converted into a single-product one. Cornerstone 3-5 illustrates the use of the package approach to calculating break-even units in the multi-product firm.

For a given sales mix, CVP analysis can be used as if the firm were selling a single product. However, actions that change the prices of individual products can affect the sales mix because consumers may buy relatively more or less of the product. Accordingly, pricing decisions may involve a new sales mix and must reflect this possibility. Keep in mind that a new sales mix will affect the units of each product that need to be sold in order to achieve a desired profit target. If the sales mix for the coming period is uncertain, it may be necessary to look at several different mixes. This is sensitivity analysis, and it gives managers insight into the possible outcomes facing the firm.

The complexity of the break-even-point-in-units approach increases dramatically as the number of products increases. Imagine performing this analysis for a firm with several hundred products. This observation seems more overwhelming than it actually is. Computers can easily handle a problem with so much data. Furthermore, many firms simplify the problem by analyzing product groups rather than individual products. Another way to handle the increased complexity is to switch from the units-sold to the sales-revenue approach. This approach can accomplish a multiple-product CVP analysis using only the summary data found in an organization's income statement. The computational requirements are much simpler.

To illustrate the break-even point in sales revenue, the same examples will be used. However, the only information needed is the projected income statement for Blazin-Boards Company as a whole.

	Total Snowboards
Sales	\$5,500,000
Less: Variable expenses	3,150,000
Contribution margin	2,350,000
Less: Total fixed expenses	800,000
Operating income	\$1,550,000

CORNERSTONE 3-5

The HOW and WHY of Calculating the Break-Even Number of Units in a Multi-Product Firm

Information:

Blazin-Boards Company plans to sell 10,000 regular snowboards and 2,500 deluxe snowboards in the coming year. Product price and cost information includes:

	Regular Snowboard	Deluxe Snowboard
Price	$ 400	$ 600
Unit variable cost	240	300
Direct fixed cost	400,000	200,000

Common fixed selling and administrative expense totals $200,000.

Why:

The break-even point in units gives managers a starting point for increasing profitability. If the company is making a loss, the break-even point tells management just what needs to be done to stop losing money. Once the break-even point is passed, the company will earn a profit. By looking at break-even points for each product, managers can see whether one product is being "carried" by other products.

Required:

1. What is the sales mix estimated for next year (calculated to the lowest whole number for each product)?
2. Using the sales mix from Requirement 1, form a package of regular and deluxe snowboards. Taking the package contribution margin to three decimal places, calculate the break-even number of regular snowboards and deluxe snowboards.
3. Prepare a contribution-margin-based income statement for Blazin-Boards Company based on the unit sales calculated in Requirement 2.
4. ***What if*** Blazin-Boards believed that 10,000 regular snowboards and 5,000 deluxe snowboards could be sold? What is the sales mix, and how many regular and deluxe snowboards must be produced and sold at break-even?

Solution:

1. Sales mix of regular to deluxe snowboards = 10,000:2,500 = 4:1
2.

Product	Price	Unit Variable Cost	Unit Contribution Margin	Sales Mix	Unit Contribution Margin × Sales Mix
Regular	$400	$240	$160	4	$640[a]
Deluxe	$600	$300	$300	1	300[b]
Package contribution margin					$940

[a]Found by multiplying the number of units in the package (4) by the unit contribution margin ($160).
[b]Found by multiplying the number of units in the package (1) by the unit contribution margin ($300).

$$\begin{aligned}\text{Break-even packages} &= \text{Total fixed cost}/\text{Package contribution margin}\\ &= (\$400{,}000 + \$200{,}000 + \$200{,}000)/\$940\\ &= 851.064 \text{ packages}\end{aligned}$$

CORNERSTONE 3-5 *(continued)*

Break-even regular snowboards $= (4 \times 851.064) = 3{,}404$
Break-even deluxe snowboards $= (1 \times 851.064) = 851$

Note: Packages are not rounded off to a whole number because the number of packages is not an end in itself. The decimal amount may be important when multiplied by the sales mix. The number of snowboards is rounded to whole units, since no one will buy a fraction of a snowboard.

3.

Blazin-Boards
Income Statement
For the Coming Year

	Regular Snowboards	Deluxe Snowboards	Total
Sales	$1,361,600	$510,600	$1,872,200
Less: Variable expenses	816,960	255,300	1,072,260
Contribution margin	544,640	255,300	799,940
Less: Direct fixed expenses	400,000	200,000	600,000
Product margin	$ 144,640	$ 55,300	199,940
Less: Common fixed expenses			200,000
Operating income			$ (60)

4. The sales mix is 10,000:5,000, or 2:1.

Product	Price	Unit Variable Cost	Unit Contribution Margin	Sales Mix	Unit Contribution Margin × Sales Mix
Regular	$400	$240	$160	2	$320[a]
Deluxe	$600	$300	$300	1	300[b]
Package contribution margin					$620

[a]Found by multiplying the number of units in the package (2) by the unit contribution margin ($160).
[b]Found by multiplying the number of units in the package (1) by the unit contribution margin ($300).

Break-even packages = Total fixed cost/Package contribution margin
$= (\$400{,}000 + \$200{,}000 + \$200{,}000)/\$620$
$= 1{,}290.323$ packages

Break-even regular snowboards $= (2 \times 1{,}290.323) = 2{,}581$ (rounded)
Break-even deluxe snowboards $= (1 \times 1{,}290.323) = 1{,}290$ (rounded)

Notice that this income statement corresponds to the total column of the more detailed income statement examined previously. The projected income statement rests on the assumption that 10,000 regular snowboards and 2,500 deluxe snowboards will be sold (a 4:1 sales mix). The break-even point in sales revenue also rests on the expected sales mix. (As with the units-sold approach, a different sales mix will produce different results.)

With the income statement, the usual CVP questions can be addressed. For example, how much sales revenue must be earned to break even? To answer this question, we divide the total fixed costs of $800,000 by the contribution margin ratio of 0.4273 ($2,350,000/$5,500,000).

$$\begin{aligned}\text{Break-even sales} &= \text{Fixed costs}/\text{Contribution margin ratio}\\ &= \$800,000/0.4273\\ &= \$1,872,221\end{aligned}$$

The break-even point in sales revenue implicitly uses the assumed sales mix but avoids the requirement of building a package contribution margin. No knowledge of individual product data is needed. The computational effort is similar to that used in the single-product setting. Moreover, the answer is still expressed in sales revenue. Unlike the break-even point in units, the answer to CVP questions using sales revenue is still expressed in a single summary measure. The sales-revenue approach, however, does sacrifice information concerning individual product performance.

OBJECTIVE 4

Prepare a profit-volume graph and a cost-volume-profit graph, and explain the meaning of each.

Graphical Representation of CVP Relationships

A graphical representation can help managers see the difference between variable cost and revenue and deepens their understanding of CVP relationships. It may also help managers understand quickly what impact an increase or decrease in sales will have on the break-even point. Two basic graphs, the profit-volume graph and the cost-volume-profit graph, are presented here.

The Profit-Volume Graph

A **profit-volume graph** portrays the relationship between profits and sales volume. The profit-volume graph is the graph of the operating income equation [Operating income = (Price × Units) − (Unit variable cost × Units) − Fixed costs]. In this graph, operating income (profit) is the dependent variable, and number of units is the independent variable. Usually, values of the independent variable are measured along the horizontal axis and values of the dependent variable along the vertical axis.

To make this discussion more concrete, a simple set of data will be used. Assume that Gordon Company produces a single product with the following cost and price data:

Total fixed costs	$100
Variable cost per unit	$ 5
Selling price per unit	$ 10

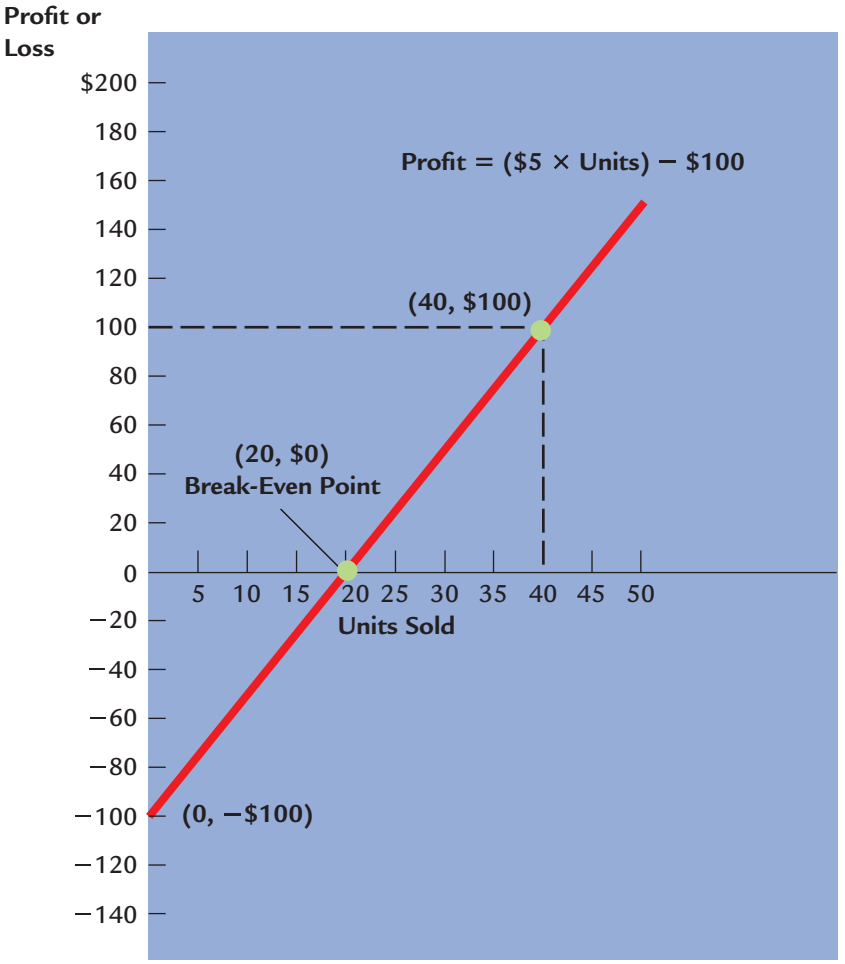
Using these data, operating income can be expressed as follows:

$$\begin{aligned}\text{Operating income} &= (\$10 \times \text{Units}) - (\$5 \times \text{Units}) - \$100\\ &= (\$5 \times \text{Units}) - \$100\end{aligned}$$

This relationship is graphed by plotting units along the horizontal axis and operating income (or loss) along the vertical axis. Two points are needed to graph a linear equation. While any two points will do, the two points often chosen are those that correspond to zero sales volume and zero profits. When units sold are zero, Gordon experiences an operating loss of $100 (or a profit of −$100). The point corresponding to zero sales volume, therefore, is (0, −$100). In other words, when no sales take place, the company suffers a loss equal to its total fixed costs. When operating income is zero, the units sold are equal to 20. The point corresponding to zero profits (break-even) is (20, $0). These two points, plotted in Exhibit 3-2, define the profit graph shown in the same figure.

Exhibit 3-2

Profit-Volume Graph



The graph in Exhibit 3-2 can be used to assess Gordon's profit (or loss) at any level of sales activity. For example, the profit associated with the sale of 40 units can be read from the graph by (1) drawing a vertical line from the horizontal axis to the profit line and (2) drawing a horizontal line from the profit line to the vertical axis. As we can see, the profit associated with sales of 40 units is $100. The profit-volume graph, while easy to interpret, fails to reveal how costs change as sales volume changes. A more comprehensive graph provides this detail.

The Cost-Volume-Profit Graph

The **cost-volume-profit graph** depicts the relationships among cost, volume, and profits. To obtain the more detailed relationships, it is necessary to graph two separate lines: the total revenue line and the total cost line. These lines are represented, respectively, by the following two equations:

$$\text{Revenue} = \text{Price} \times \text{Units}$$
$$\text{Total cost} = (\text{Unit variable cost} \times \text{Units}) + \text{Fixed costs}$$

Using the Gordon Company example, the revenue and cost equations are as follows:

$$\text{Revenue} = \$10 \times \text{Units}$$
$$\text{Total cost} = (\$5 \times \text{Units}) + \$100$$

To portray both equations in the same graph, the vertical axis is measured in dollars and the horizontal axis in units sold.

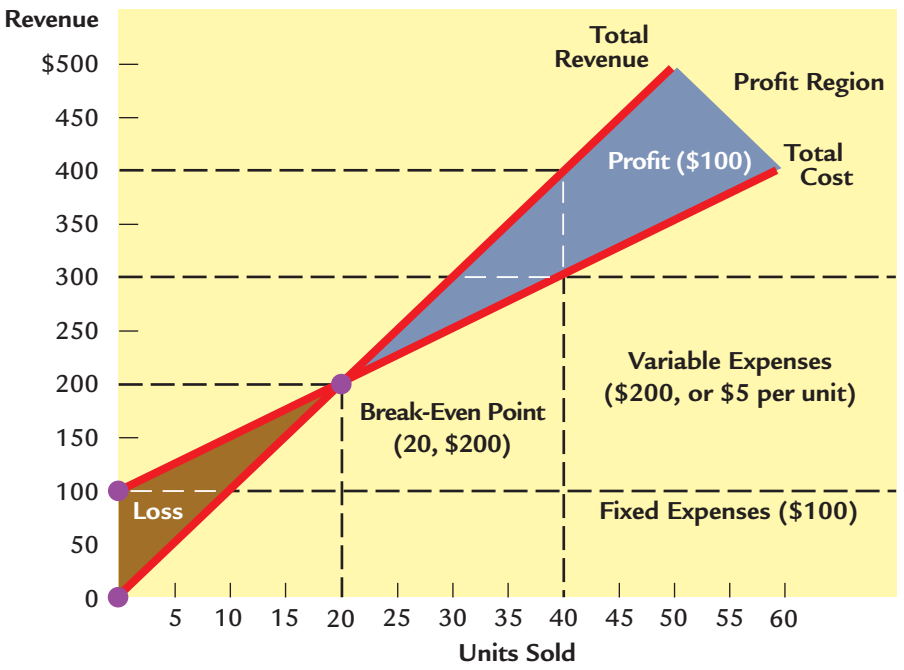
Two points are needed to graph each equation. We will use the same x-coordinates used for the profit-volume graph. For the revenue equation, setting number of units equal to zero results in revenue of $0; setting number of units equal to 20 results in revenue of $200. Therefore, the two points for the revenue equation are (0, $0) and (20, $200). For the cost equation, units sold of zero and units sold equal to 20 produce the points (0, $100) and (20, $200). The graphs of both equations appear in Exhibit 3-3.

Notice that the total revenue line begins at the origin and rises with a slope equal to the selling price per unit (a slope of 10). The total cost line intercepts the vertical axis at a point equal to total fixed costs and rises with a slope equal to the variable cost per unit (a slope of 5). When the total revenue line lies below the total cost line, a loss region is defined. Similarly, when the total revenue line lies above the total cost line, a profit region is defined. The point where the total revenue line and the total cost line intersect is the break-even point. To break even, Gordon Company must sell 20 units and thus receive $200 in total revenues.

Now, let's compare the information available from the CVP graph to that available from the profit-volume graph. To do so, consider the sale of 40 units. Recall that the profit-volume graph revealed that selling 40 units produced profit of $100. Examine Exhibit 3-3 again. The CVP graph also shows profits of $100, but it reveals more than that. The CVP graph discloses that total revenues of $400 and total costs of $300 are associated with the sale of 40 units. Furthermore, the total costs can be broken down into fixed costs of $100 and variable costs of $200. The CVP graph provides revenue and cost information not provided by the profit-volume graph. Unlike the profit-volume graph, some computation is needed to determine the profit associated with a given sales volume. Nonetheless, because of the greater information content, managers are likely to find the CVP graph a more useful tool.

Exhibit 3-3

Cost-Volume-Profit Graph



Assumptions of Cost-Volume-Profit Analysis

The profit-volume and cost-volume-profit graphs just illustrated rely on some important assumptions. Some of these assumptions are as follows:

1. The analysis assumes a linear revenue function and a linear cost function.
2. The analysis assumes that price, total fixed costs, and unit variable costs can be accurately identified and remain constant over the relevant range.
3. The analysis assumes that what is produced is sold.
4. For multiple-product analysis, the sales mix is assumed to be known.
5. The selling prices and costs are assumed to be known with certainty.

The first assumption, linear cost and revenue functions, deserves additional consideration. Let's take a look at the underlying revenue and total cost functions identified in economics. Exhibit 3-4, Panel A, portrays the curvilinear revenue and cost functions. We see that as quantity sold increases, revenue also increases, but eventually revenue begins to rise less steeply than before. This is explained quite simply by the need to decrease price as many more units are sold. The total cost function is more complicated, rising steeply at first, then levelling off somewhat (as increasing returns to scale develop), and then rising steeply again (as decreasing returns to scale develop). How can we deal with these complicated relationships?

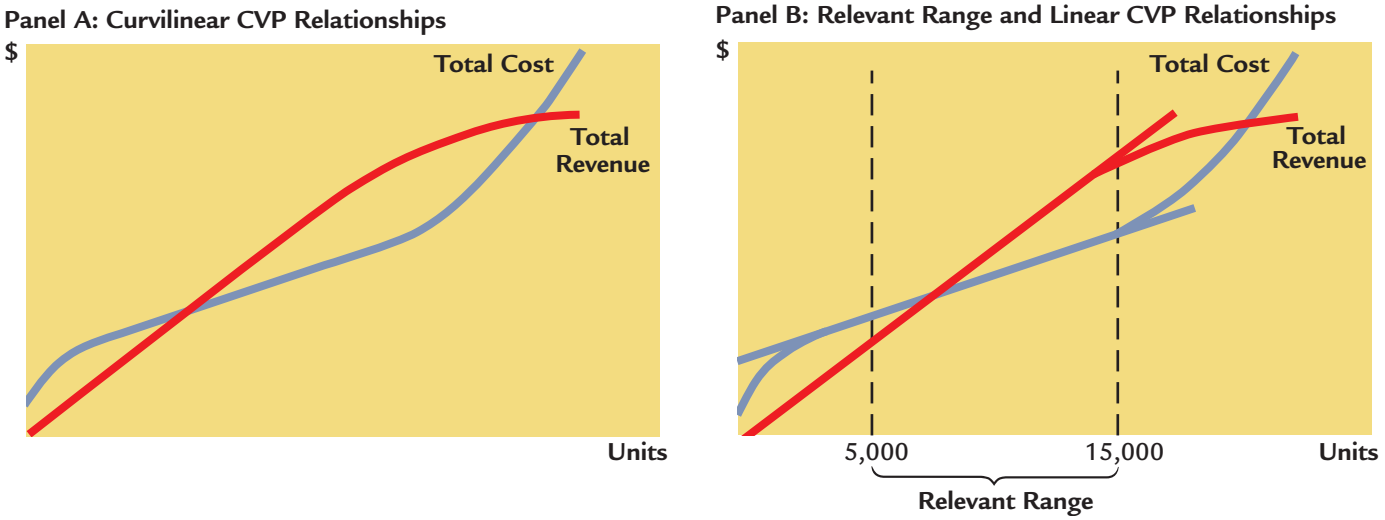
Relevant Range Fortunately, we do not need to consider all possible ranges of production and sales for a firm. Remember that CVP analysis is a short-run decision-making tool. (We know that it is short run in orientation because some costs are fixed.) It is only necessary for us to determine the current operating range, or **relevant range**, for which the linear cost and revenue relationships are valid. Exhibit 3-4, Panel B, illustrates a relevant range from 5,000 to 15,000 units. Note that the cost and revenue relationships are roughly linear in this range, allowing us to use our linear CVP equations. Of course, if the relevant range changes, different fixed and variable costs and different prices must be used.

The second assumption is linked to the definition of relevant range. Once a relevant range has been identified, then the cost and price relationships are assumed to be known and constant.

Production Equal to Sales The third assumption is that what is produced is sold. There is no change in inventory over the period. The fact that inventory has no

Exhibit 3-4

Cost and Revenue Relationships



impact on break-even analysis makes sense. Break-even analysis is a short-run decision-making technique, so we are looking to cover all costs of a particular period of time. Inventory embodies costs of a previous period and is not considered.

Constant Sales Mix The fourth assumption is a constant sales mix. In single-product analysis, the sales mix is obviously constant—100 percent of sales is applied to one product. Multiple-product break-even analysis requires a constant sales mix. However, it is virtually impossible to predict the sales mix with certainty. Typically, this constraint is handled in practice through sensitivity analysis. By using the capabilities of spreadsheet analysis, the sensitivity of variables to a variety of sales mixes can be readily assessed.

Prices and Costs Known with Certainty Finally, the fifth assumption is that prices and costs are known. In actuality, firms seldom know variable costs and fixed costs with certainty. A change in one variable usually affects the value of others. Often, there is a probability distribution with which to contend. There are formal ways of explicitly building uncertainty into the CVP model. Exploration of these issues is introduced in the next section.

OBJECTIVE 5

Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.

Changes in the CVP Variables

Because firms operate in a dynamic world, they must be aware of changes in prices, variable costs, and fixed costs. They must also account for the effects of risk and uncertainty. We will take a look at the effects on the break-even point of changes in price, unit variable cost, and fixed costs. We will also look at ways managers can handle risk and uncertainty within the CVP framework.

Let's return to the Blazin-Boards Company example before the deluxe snowboard was introduced (when only the regular snowboard is produced). Suppose that the Sales Department recently conducted a market study that revealed three different alternatives.

Alternative 1: If advertising expenditures increase by $16,500, sales will increase from 10,000 units to 10,100 units.

Alternative 2: A price decrease from $400 per snowboard to $375 per snowboard would increase sales from 10,000 units to 12,000 units.

Alternative 3: Decreasing prices to $375 and increasing advertising expenditures by $16,500 will increase sales from 10,000 units to 12,000 units.

Should Blazin-Boards maintain its current price and advertising policies, or should it select one of the three alternatives described by the marketing study?

Consider the first alternative. What is the effect on profits if advertising costs increase by $16,500 and sales increase by 100 units? This question can be answered just by using the contribution margin per unit. We know that the unit contribution margin is $160. Since units sold increase by 100, the incremental increase in total contribution margin is $16,000 ($160 × 100 units). However, since fixed costs increase by $16,500, profits will actually decrease by $500 ($16,500 − $16,000). Notice that we need to look only at the incremental increase in total contribution margin and fixed expenses to compute the increase in total profits. Exhibit 3-5 summarizes the effects of the first alternative.

For the second alternative, fixed expenses do not increase. Thus, it is possible to answer the question by looking only at the effect on total contribution margin. For the current price of $400, the contribution margin per unit is $160. If 10,000 units are sold, the total contribution margin is $1,600,000 ($160 × 10,000). If the price is dropped to $375, then the contribution margin drops to $135 per unit ($375 − $240). If 12,000 units are sold at the new price, then the new total contribution margin is $1,620,000 ($135 × 12,000). As shown in Exhibit 3-6, dropping the price results in a profit increase of $20,000 ($1,620,000 − $1,600,000).

Exhibit 3-5

Summary of the Effects of Alternative 1

	Before the Increased Advertising	With the Increased Advertising
Units sold	10,000	10,100
Unit contribution margin	× $160	× $160
Total contribution margin	$1,600,000	$1,616,000
Less: Fixed expenses	1,200,000	1,216,500
Profit	$ 400,000	$ 399,500

	Difference in Profit
Change in sales volume	100
Unit contribution margin	× $160
Change in contribution margin	$16,000
Less: Increase in fixed expenses	16,500
Decrease in profit	$ (500)

Exhibit 3-6

Summary of the Effects of Alternative 2

New contribution margin ($135 × 12,000 units)	$1,620,000
Old contribution margin ($160 × 10,000 units)	1,600,000
Increased contribution margin	$ 20,000

The third alternative calls for a decrease in the unit selling price and an increase in advertising costs. Like the first alternative, the profit impact can be assessed by looking at the incremental effects on contribution margin and fixed expenses. The incremental profit change can be found by (1) computing the incremental change in total contribution margin, (2) computing the incremental change in fixed expenses, and (3) adding the two results.

The current total contribution margin for 10,000 units sold is $1,600,000. Since the new unit contribution margin is $135, and units sold increase to 12,000, the new total contribution margin is $1,620,000 ($135 × 12,000 units). Thus, the incremental increase in total contribution margin is $20,000 ($1,620,000 − $1,600,000). However, to achieve this incremental increase in contribution margin, an incremental increase of $16,500 in fixed costs is needed. The net effect is an incremental increase in profits of $3,500. The effects of the third alternative are summarized in Exhibit 3-7.

Of the three alternatives identified by the marketing study, both the second and third alternatives promise a benefit. They increase total profits by $20,000 (alternative 2) and $3,500 (alternative 3). Clearly, alternative 2 has a higher profit potential.

These examples are all based on a units-sold approach. However, we could just as easily have applied a sales-revenue approach. The answers would be the same.

Introducing Risk and Uncertainty

An important assumption of CVP analysis is that prices and costs are known with certainty. This is seldom the case. Risk and uncertainty are a part of business decision making and must be considered. Formally, risk differs from uncertainty in that with risk, the probability distributions of the variables are known. With uncertainty, the probability distributions are not known. For our purposes, however, the terms will be used interchangeably.

Exhibit 3-7

Summary of the Effects of Alternative 3

	Before Changes	With the Increased Advertising and Decreased Price
Units sold	10,000	12,000
Unit contribution margin	× $160	× $135
Total contribution margin	$1,600,000	$1,620,000
Less: Fixed expenses	1,200,000	1,216,500
Profit	$ 400,000	$ 403,500

	Difference in Profit
Decrease in contribution margin on 10,000 units	$(250,000)
Increase in contribution margin on 2,000 units	270,000
Change in contribution margin	$ 20,000
Less: Increase in fixed expenses	16,500
Increase in profit	$ 3,500

Managers deal with risk and uncertainty in a variety of ways. First, of course, management must realize the uncertain nature of future prices, costs, and quantities. Next, managers move from consideration of a break-even point to what might be called a break-even band. In other words, given the uncertain nature of the data, perhaps a firm might break even when 1,800 to 2,000 units are sold—instead of the point estimate of 1,900 units. Furthermore, managers may engage in sensitivity or what-if analyses. Here, a computer spreadsheet is helpful, as managers set up the break-even (or targeted profit) relationships and then check to see the impact that varying costs and prices have on quantity sold. Two concepts useful to management are *margin of safety* and *operating leverage*. Both of these may be considered measures of risk. Each requires knowledge of fixed and variable costs.

Margin of Safety The **margin of safety** is the units sold or expected to be sold or the revenue earned or expected to be earned above the break-even volume. Cornerstone 3-6 illustrates the margin of safety.

The margin of safety can be viewed as a crude measure of risk. There are always events, unknown when plans are made, that can lower sales below the original expected level. If a firm's margin of safety is large given the expected sales for the coming year, the risk of suffering losses should sales take a downward turn is less than if the margin of safety is small. Managers who face a low margin of safety may wish to consider actions to increase sales or decrease costs.

For example, **Walt Disney Company** faced lower theme park earnings in the last quarter of 2004 due to the unprecedented number of hurricanes that hit Florida during August. Disney's CFO explained that "near-term local attendance could be impacted as people put their lives together" after the disasters. He also noted that the company would focus on "increasing occupancy at theme park hotels, per capita spending by visitors to the theme parks, and managing costs." The objective is to reach an operating margin of at least 20 percent over the next three to four years.[4] A more robust operating margin at all theme parks would cushion Disney in the event of unforeseen events.

[4] Dwight Oestricher, "Disney CFO Staggs Sees Theme Park 1Q Hurt by Storms," *The Wall Street Journal* (September 30, 2004): B1 and B2.

The HOW and WHY of Calculating Margin of Safety

CORNERSTONE 3-6

Information:

Blazin-Boards Company plans to sell 10,000 snowboards at $400 each in the coming year. Product costs include:

Direct materials per snowboard	$80
Direct labour per snowboard	$125
Variable overhead per snowboard	$15
Total fixed factory overhead	$800,000

Variable selling expense is a commission of 5 percent of price; fixed selling and administrative expense totals $400,000.

Why:

Margin of safety is a crude measure of risk. The further above the break-even point, the larger the margin of safety and the further the company is away from break-even and a loss.

Required:

1. Calculate the margin of safety in units for the coming year. (Recall that the break-even point in units was calculated in Cornerstone 3-2.)
2. Calculate the break-even sales and the margin of safety in sales for the coming year.
3. ***What if*** Blazin-Boards Company actually sells 9,800 snowboards in the coming year? Calculate the margin of safety in units and sales revenue.

Solution:

1. Margin of safety = 10,000 units − 7,500 units = 2,500 units
2. Break-even sales = 7,500 units × $400 = $3,000,000
   Margin of safety = (10,000 units × $400) − $3,000,000 = $1,000,000
3. Margin of safety = 9,800 units − 7,500 units = 2,300 units
   Margin of safety = (9,800 units × $400) − $3,000,000 = $920,000

Operating Leverage In physics, a lever is a simple machine used to multiply force. Basically, the lever magnifies the amount of effort applied to create a greater effect. The larger the load moved by a given amount of effort, the greater the mechanical advantage. In financial terms, operating leverage is concerned with the relative mix of fixed costs and variable costs in an organization. It is sometimes possible to trade off fixed costs for variable costs. As variable costs decrease, the unit contribution margin increases, making the contribution of each unit sold that much greater. In such a case, the effect of fluctuations in sales on profitability increases. Thus, firms that have lowered variable costs by increasing the proportion of fixed costs will benefit with greater increases in profits as sales increase than will firms with a lower proportion of fixed costs. Fixed costs are being used as leverage to increase profits. Unfortunately, it is also true that firms with a higher operating leverage will also experience greater reductions in profits as sales decrease. Therefore, **operating leverage** is the use of fixed costs to extract higher percentage changes in profits as sales activity changes.

The greater the degree of operating leverage, the more that changes in sales activity will affect profits. Because of this phenomenon, the mix of costs that an organization chooses can have a considerable influence on its operating risk and profit level.

The **degree of operating leverage** can be measured for a given level of sales by taking the ratio of total contribution margin to profit, as follows:

$$\text{Degree of operating leverage} = \text{Total contribution margin}/\text{Profit}$$

If fixed costs are used to lower variable costs such that contribution margin increases and profit decreases, then the degree of operating leverage increases—signalling an increase in risk. Cornerstone 3-7 illustrates the degree of operating leverage and the way it can be used to calculate the change in profit given a percentage change in sales.

As Cornerstone 3-7 shows, the degree of operating leverage is a valuable piece of information. It can be used to quickly determine the impact of a percentage change in sales on operating income. We see that a 40 percent increase in sales can bring a significant benefit to the firm. However, the effect is a two-edged sword. As sales decrease, the automated system will also show much higher percentage profit decreases. Moreover, the increased operating leverage is available under the automated system because of the presence of increased fixed costs. The break-even point for the automated system is 7,500 units ($375,000/$50), whereas the break-even point for the manual system is 5,000 units ($100,000/$20). Clearly, at a lower level of sales the manual system is better and at a higher level of sales the automated system is better. What is the sales level at which the manual and the automated systems are equally profitable? We can compute that by setting the operating income equations for each system equal to each other.

$$(\$100 \times \text{units}) - (\$50 \times \text{units}) - \$375{,}000 = (\$100 \times \text{units}) - (\$80 \times \text{units}) - \$100{,}000$$
$$(\$50 \times \text{units}) - \$375{,}000 = (\$20 \times \text{units}) - \$100{,}000$$
$$\text{Units} = 9{,}167 \text{ (rounded)}$$

In choosing between the automated and manual systems, the manager must assess the likelihood that sales will exceed 9,167 units. If, after careful study, there is a strong belief that sales will easily exceed this level, the choice is obvious: the automated system. On the other hand, if sales are unlikely to exceed 9,167 units, the manual system is preferable. Exhibit 3-8 summarizes the relative difference between the manual and automated systems in terms of some of the CVP concepts.

Sensitivity Analysis and CVP

The pervasiveness of personal computers and spreadsheets has made cost analysis within reach of most managers. An important tool is **sensitivity analysis**, a what-if technique that examines the impact of changes in underlying assumptions on an

Exhibit 3-8

Differences between Manual and Automated Systems

	Manual System	Automated System
Price	Same	Same
Variable costs	Relatively higher	Relatively lower
Fixed costs	Relatively lower	Relatively higher
Contribution margin	Relatively lower	Relatively higher
Break-even point	Relatively lower	Relatively higher
Margin of safety	Relatively higher	Relatively lower
Degree of operating leverage	Relatively lower	Relatively higher
Downside risk	Relatively lower	Relatively higher
Upside potential	Relatively lower	Relatively higher

The HOW and WHY of Calculating Degree of Operating Leverage and Percent Change in Profit

CORNERSTONE 3-7

Information:

Sharda Company is planning to add a new product line. To do so, the firm can choose to rely heavily on automation or on labour. Relevant data for a sales level of 10,000 units follow:

	Automated System	*Manual System*
Sales	$1,000,000	$1,000,000
Variable expenses	500,000	800,000
Contribution margin	500,000	200,000
Less total fixed expenses	375,000	100,000
Operating income	$ 125,000	$ 100,000
Unit selling price	$ 100	$ 100
Unit variable cost	50	80
Unit contribution margin	50	20

Why:

The automated system has higher fixed costs, lower variable costs, and a higher contribution margin per unit. The higher fixed costs are used to extract more contribution margin from each unit sold, and this system will pay off nicely—if unit sales are high enough. The manual system will be less risky if unit sales are lower. The degree of operating leverage can help a firm determine how much riskier the automated system is.

Required:

1. Compute the degree of operating leverage for each system.
2. Suppose that sales are 40 percent higher than budgeted. By what percentage will operating income increase for each system? What will be the *increase* in operating income for each system?
3. ***What if*** unit sales are 30 percent lower than budgeted? By what percentage will operating income decrease for each system? What will be the *total operating income* for each system?

Solution:

1. Degree of operating leverage = Contribution margin/Profit
   Automated system degree of operating leverage = $500,000/$125,000 = 4.0
   Manual system degree of operating leverage = $200,000/$100,000 = 2.0

2. Automated system increase in profit percentage = 4.0 × 40% = 160%
   Manual system increase in profit percentage = 2.0 × 40% = 80%
   Automated system increase in profit = 1.6 × $125,000 = $200,000
   Manual system increase in profit = 0.8 × $100,000 = $80,000
   Automated system new profit = $125,000 + $200,000 = $325,000
   Manual system new profit = $100,000 + $80,000 = $180,000

3. Automated system decrease in profit percentage = 4.0 × 30% = 120%
   Manual system decrease in profit percentage = 2.0 × 30% = 60%
   Automated system decrease in profit = 1.2 × $125,000 = $150,000
   Manual system decrease in profit = 0.6 × $100,000 = $60,000
   Automated system new profit = $125,000 − $150,000 = $(25,000)
   Manual system new profit = $100,000 − $60,000 = $40,000

answer. It is relatively simple to input data on prices, variable costs, fixed costs, and sales mix and set up formulas to calculate break-even points and expected profits. Then, the data can be varied as desired to see what impact changes have on the expected profit.

In Cornerstone 3-7, a company analyzed the impact on profit of using an automated versus a manual system. The computations were essentially done by hand, and too much variation was cumbersome. Using the power of a computer, it would be an easy matter to change the sales price in $1 increments between $75 and $125, with related assumptions about quantity sold. At the same time, variable and fixed costs could be adjusted. For example, suppose that the automated system has fixed costs of $375,000, but that those costs could easily range up to twice as much in the first year and come back down in the second and third years as bugs are worked out of the system and workers learn to use it. Again, the spreadsheet can effortlessly handle the many computations.

We must note that the spreadsheet, while wonderful for cranking out numerical answers, cannot do the most difficult job in CVP analysis. That job is determining the data to be entered in the first place. The accountant must be familiar with the cost and price distributions of the firm, as well as with the impact of changing economic conditions on these variables. The fact that variables are seldom known with certainty is no excuse for ignoring the impact of uncertainty on CVP analysis. Fortunately, sensitivity analysis can also give managers a feel for the degree to which a poorly forecast variable will affect an answer. That is also an advantage.

ETHICS Finally, it is important to note that the CVP results are only one input into business decisions. There are many other factors that may bear on decisions to choose one type of process over another, for example, or whether to delete certain costs. Businesses and nonprofit entities often face trade-offs involving safety. Ethical concerns also have an important place in CVP analysis. One possibility is that the cost of potential problems can be estimated and included in the CVP results. Often, however, the costs and probabilities are not known with sufficient certainty. In that case, these factors are included as qualitative factors in the ultimate decision-making process. Chapter 11, on short-run decision making, covers this topic in more detail.◆

OBJECTIVE 6

Discuss the impact of non-unit cost drivers on cost-volume-profit analysis.

CVP Analysis and Non-Unit Cost Drivers

Conventional CVP analysis assumes that all costs of the firm can be divided into two categories: those that vary with sales volume (variable costs) and those that do not (fixed costs). Furthermore, costs are assumed to be a linear function of sales volume. Frequently, however, there are costs that vary with non-unit cost drivers. An activity-based costing (ABC) system, in which costs are divided into unit- and non-unit-based categories, is a good example of this. Some costs, such as setting up production equipment, vary with the number of batches; other costs, such as purchasing and receiving costs, may vary with the number of different products. In conventional CVP, those non-unit variable costs are assumed to be fixed. However, CVP can be modified to take account of this richer set of variable costs. This type of modification can make CVP even more useful, since it provides more accurate insights concerning cost behaviour. These insights produce better decisions.

To illustrate, assume that a company's costs can be explained by three variables: a unit-level cost driver, units sold; a batch-level cost driver, number of setups; and a product-level cost driver, engineering hours. The cost equation can then be expressed as follows:

$$\text{Total cost} = \text{Fixed costs} + (\text{Unit variable cost} \times \text{Number of units}) + (\text{Setup cost} \times \text{Number of setups}) + (\text{Engineering cost} \times \text{Number of engineering hours})$$

Operating income, as before, is total revenue minus total cost. This is expressed as follows:

$$\text{Operating income} = \text{Total revenue} - [\text{Fixed costs} + (\text{Unit variable cost} \times \text{Number of units}) + (\text{Setup cost} \times \text{Number of setups}) + (\text{Engineering cost} \times \text{Number of engineering hours})]$$

Let's use the contribution margin approach to calculate the break-even point in units. At break-even, operating income is zero, and the number of units that must be sold to achieve break-even is as follows:

$$\text{Break-even units} = [\text{Fixed costs} + (\text{Setup cost} \times \text{Number of setups}) + (\text{Engineering cost} \times \text{Number of engineering hours})]/(\text{Price} - \text{Unit variable cost})$$

A comparison of the ABC break-even point with the conventional break-even point reveals two significant differences. First, the fixed costs differ. Some costs previously identified as being fixed may actually vary with non-unit cost drivers, in this case setups and engineering hours. Second, the numerator of the ABC break-even equation has two non-unit-variable cost terms: one for batch-related activities and one for product-sustaining activities.

Example Comparing Conventional and ABC Analysis

To make the previous discussion more concrete, a comparison of conventional cost-volume-profit analysis with activity-based costing is useful. Let's assume that a company wants to compute the units that must be sold to earn a before-tax profit of $20,000. The analysis is based on the following data:

Data about Variables

Cost Driver	Unit Variable Cost	Level of Cost Driver
Units sold	$10	—
Setups	1,000	20
Engineering hours	30	1,000

Other data:

Total fixed costs (conventional)	$100,000
Total fixed costs (ABC)	50,000
Unit selling price	20

The units that must be sold to earn a before-tax profit of $20,000 are computed as follows:

$$\begin{aligned}\text{Units} &= (\text{Targeted income} + \text{Fixed costs})/(\text{Price} - \text{Unit variable cost})\\ &= (\$20{,}000 + \$100{,}000)/(\$20 - \$10)\\ &= \$120{,}000/\$10\\ &= 12{,}000\end{aligned}$$

Using the ABC equation, the units that must be sold to earn an operating income of $20,000 are computed as follows:

$$\begin{aligned}\text{Units} &= [\text{Targeted income} + \text{Fixed costs} + (\text{Setup cost} \times \text{Setups}) +\\ &\quad (\text{Engineering rate} \times \text{Engineering hours})]/(\text{Price} - \text{Unit variable cost})\\ &= (\$20{,}000 + \$50{,}000 + \$20{,}000 + \$30{,}000)/(\$20 - \$10)\\ &= \$120{,}000/\$10\\ &= 12{,}000\end{aligned}$$

The number of units that must be sold is identical under both approaches. The reason is simple. The total fixed cost pool under conventional costing consists of non-unit-based variable costs plus costs that are fixed regardless of the cost driver. ABC breaks out the non-unit-based variable costs. These costs are associated with certain levels of each cost driver. For the batch-level cost driver, the level is 20 setups; for the product-level variable, the level is 1,000 engineering hours. As long as the levels of activity for the non-unit-based cost drivers remain the same, the results for the conventional and ABC computations will also be the same. But these levels can change, and because of this, the information provided by the two approaches can be significantly different. The ABC equation for CVP analysis is a richer representation of the underlying cost behaviour and can provide important strategic insights. To see this, let's use the same data provided previously and look at a different application.

Strategic Implications: Conventional CVP Analysis versus ABC Analysis

Suppose that after the conventional CVP analysis, marketing indicates that only 10,000 units can be sold, not the 12,000 anticipated earlier. The president of the company directs the product design engineers to find a way to reduce the cost of making the product. The engineers also have been told that the conventional cost equation, with fixed costs of $100,000 and a unit variable cost of $10, is accurate. The variable cost of $10 per unit consists of the following: direct labour, $4; direct materials, $5; and variable overhead, $1. To comply with the request to reduce the break-even point, engineering produces a new design that requires less labour, thereby reducing the direct labour cost by $2 per unit. The design would not affect direct materials or variable overhead. The new variable cost is $8 per unit, and the break-even point is calculated as follows:

$$\begin{aligned}\text{Units} &= \text{Fixed costs}/(\text{Price} - \text{Unit variable cost})\\ &= \$100{,}000/(\$20 - \$8)\\ &= 8{,}333\end{aligned}$$

The projected income if 10,000 units are sold is computed as follows:

Sales ($20 × 10,000)	$200,000
Less: Variable expenses ($8 × 10,000)	80,000
Contribution margin	120,000
Less: Fixed expenses	100,000
Operating income	$ 20,000

Excited, the president approves the new design. A year later, the president discovers that the expected increase in income did not materialize. In fact, there was a loss. Why? The answer is provided by an ABC approach to CVP analysis.

The original ABC cost relationship for the example is as follows:

$$\text{Total cost} = \$50{,}000 + (\$10 \times \text{Units}) + (\$1{,}000 \times \text{Setups}) + (\$30 \times \text{Engineering hours})$$

Suppose that the new design requires a more complex setup, increasing the cost per setup from $1,000 to $1,600. Also, suppose that the new design, because of increased technical content, requires a 40 percent increase in engineering support (from 1,000 hours to 1,400 hours). The new cost equation, including the reduction in unit-level variable costs, is as follows:

$$\text{Total cost} = \$50{,}000 + (\$8 \times \text{Units}) + (\$1{,}600 \times \text{Setups}) + (\$30 \times \text{Engineering hours})$$

The break-even point, setting operating income equal to zero and using the ABC equation, is calculated as follows (assume that 20 setups are still performed):

$$\begin{aligned}\text{Units} &= [\$50{,}000 + (\$1{,}600 \times 20) + (\$30 \times 1{,}400)]/(\$20 - \$8)\\ &= \$124{,}000/\$12\\ &= 10{,}333\end{aligned}$$

And the income for 10,000 units is (recall that a maximum of 10,000 can be sold) as follows:

Sales ($20 × 10,000)		$200,000
Less: Unit-based variable expenses ($8 × 10,000)		80,000
Contribution margin		120,000
Less non-unit-based variable expenses:		
Setups ($1,600 × 20)	$32,000	
Engineering support ($30 × 1,400)	42,000	74,000
Traceable margin		46,000
Less: Fixed expenses		50,000
Operating income (loss)		$ (4,000)

How could the engineers have been off by so much? Didn't they know that the new design would increase setup cost and engineering support? Yes and no. They were probably aware of the increases in these two variables, but the conventional cost equation diverted attention from figuring just how much impact changes in those variables would have on units needed to break even. The information conveyed to the engineers by the conventional equation gave the impression that any reduction in labour cost—not affecting direct materials or variable overhead—would reduce total costs, since changes in the level of labour activity would not affect the fixed costs. The ABC equation, however, indicates that a reduction in labour input that adversely affects setup activity or engineering support might be undesirable. When more insight is provided, better design decisions can be made. Providing ABC cost information to the design engineers would probably have led them down a different—and better—path for the company.

CVP Analysis and JIT

If a firm has adopted JIT, the variable cost per unit sold is reduced, and fixed costs are increased. Direct labour, for example, is now viewed as fixed instead of variable. Direct materials, on the other hand, is still a unit-based variable cost. In fact, the emphasis on total quality and long-term purchasing makes the assumption even more true that direct materials cost is strictly proportional to units produced (because waste, scrap, and quantity discounts are eliminated). Other unit-based variable costs such as power and sales commissions also persist. Additionally, the batch-level variable is gone (in JIT, the batch is one unit). Thus, the cost equation for JIT can be expressed as follows:

$$\text{Total cost} = \text{Fixed costs} + (\text{Unit variable cost} \times \text{Units}) + (\text{Engineering cost} \times \text{Number of engineering hours})$$

Since its application is a special case of the ABC equation, no example will be given.

CVP Analysis, Multiple Drivers, and Nonprofit Entities

Clearly, cost-volume-profit analysis is helpful for manufacturing and service firms. It is also useful for not-for-profit entities. In the case of a nonprofit organization, there may be a variety of ways of gaining revenue and a variety of programs that generate costs. As a result, the straightforward application of cost-volume-profit equations may not be possible. Then, the managers will need to become aware of the different types of costs, the different drivers, and the underlying economic conditions that affect them.

Canadians are passionate about hockey, but it is difficult for teams below the **National Hockey League** level to make a profit. The teams that compete for the Allan Cup (viewed by some to be second only to the Stanley Cup in terms of prestige) often come from smaller communities and must rely on various sources of revenue in order to break even. Variable costs include "game day" costs for labour and supplies; fixed costs relate to the cost of the venue, the players and coaches, stipends, and equipment. Revenues come from many sources, including gate receipts, concession and merchandise sales, and other community support, which often takes the form of fundraising efforts. All sources of revenue and expenses must be considered in order to determine the revenue level that will allow a team to break even.

Knowing the cost structure makes it easier for the team to see just where cost cuts are possible and where revenue increases must be found. In cases like this, it might be best to use a spreadsheet to calculate costs and revenues under various scenarios.

Summary of Learning Objectives

1. Determine the number of units and amount of sales revenue needed to break even and to earn a target profit.

- At break-even, total costs (variable and fixed) equal total sales revenue.
- Break-even units equal total fixed costs divided by the contribution margin (price minus variable cost per unit).
- Break-even revenue equals total fixed costs divided by the contribution margin ratio.
- To earn a target (desired) profit, total costs (variable and fixed) plus the amount of target profit must equal total sales revenue.
- Units to earn target profit equal total fixed costs plus target profit divided by the contribution margin.
- Sales revenue to earn target profit equals total fixed costs plus target profit divided by the contribution margin ratio.

2. Determine the number of units and sales revenue needed to earn an after-tax target profit.

- Desired after-tax profit must be converted into before-tax profit to calculate units or revenue needed.
- To find the operating income implied by a certain after-tax profit, divide the after-tax profit by (1 − tax rate).
- Apply the break-even equations as before to the newly calculated before-tax profit target.

3. Apply cost-volume-profit analysis in a multiple-product setting.

- Multiple-product analysis requires the expected sales mix.
- Break-even units for each product will change as the sales mix changes.
- Increased sales of high contribution margin products decrease the break-even point.
- Increased sales of low contribution margin products increase the break-even point.

4. Prepare a profit-volume graph and a cost-volume-profit graph, and explain the meaning of each.

- CVP assumes linear revenue and cost functions, no finished goods ending inventories, constant sales mix, and that selling prices and fixed and variable costs are known with certainty.
- Profit-volume graphs plot the relationship between profit (operating income) and units sold. Break-even units are shown where the profit line crosses the horizontal axis.
- CVP graphs plot a line for total costs and a line for total sales revenue. The intersection of these two lines is the break-even point in units.

5. Explain the impact of risk, uncertainty, and changing variables on cost-volume-profit analysis.

- Uncertainty regarding costs, prices, and sales mix affect the break-even point.
- Sensitivity analysis allows managers to vary costs, prices, and sales mix to show various possible break-even points.
- Margin of safety shows how far the company's actual sales and/or units are above or below the break-even point.
- Operating leverage is the use of fixed costs to increase the percentage changes in profits as sales activity changes.

6. Discuss the impact of non-unit cost drivers on cost-volume-profit analysis.

- Under ABC, cost drivers are separated into unit-based and non-unit-based drivers.
- Variable rates for the non-unit-based drivers are multiplied by the estimated level of the drivers and added to total fixed costs.
- The standard CVP models still hold under ABC.

Summary of Important Equations

The subject of cost-volume-profit analysis naturally lends itself to the use of numerous equations. Some of the more common equations used in this chapter are summarized in Exhibit 3-9.

Exhibit 3-9

Summary of Important Equations

1. Sales revenue = Price × Units sold
2. Operating income = (Price × Units) − (Unit variable cost × Units) − Fixed cost
3. Break-even point in units = Fixed cost/(Price − Unit variable cost)
4. Contribution margin ratio = Contribution margin/Sales
   or = (Price − Unit variable cost)/Price
5. Variable cost ratio = Total variable cost/Sales
   or = Unit variable cost/Price
6. Break-even point in sales revenue = Fixed cost/Contribution margin ratio
   or = Fixed cost/(1 − Variable cost ratio)
7. Margin of safety = Sales − Break-even sales
   or = Units sold − Break-even units
8. Degree of operating leverage = Total contribution margin/Operating income
9. Percentage change in operating income = Degree of operating leverage × Percent change in sales

CORNERSTONES FOR CHAPTER 3

Review Problems

I. Break-Even Point, Targeted Profit, Margin of Safety

Cutlass Company's projected profit for the coming year is as follows:

	Total	Per Unit
Sales	$200,000	$20
Less: Variable expenses	120,000	12
Contribution margin	80,000	$ 8
Less: Fixed expenses	64,000	
Operating income	$ 16,000	

Required:

1. Compute the break-even point in units.
2. How many units must be sold to earn a profit of $30,000?
3. Compute the contribution margin ratio. Using that ratio, compute the additional profit that Cutlass would earn if sales were $25,000 more than expected.
4. Suppose Cutlass would like to earn operating income equal to 20 percent of sales revenue. How many units must be sold for this goal to be realized? Prepare an income statement to prove your answer.
5. For the projected level of sales, compute the margin of safety.
6. For the projected level of sales, compute the degree of operating leverage. What is the percent change in profit if sales increase by 15 percent?

Solution:

1. The break-even point is as follows:

$$\begin{aligned}\text{Units} &= \text{Fixed costs}/(\text{Price} - \text{Unit variable cost})\\ &= \$64{,}000/(\$20 - \$12)\\ &= \$64{,}000/\$8\\ &= 8{,}000\end{aligned}$$

2. The units sold to earn a profit of $30,000 is as follows::

$$\begin{aligned}\text{Units} &= (\$64{,}000 + \$30{,}000)/\$8\\ &= \$94{,}000/\$8\\ &= 11{,}750\end{aligned}$$

3. The contribution margin ratio is $\$8/\$20 = 0.40$. With additional sales of $25,000, the additional profit would be $0.40 \times \$25{,}000 = \$10{,}000$.
4. To find the number of units sold for a profit equal to 20 percent of sales, let target income equal $(0.20)(\text{Price} \times \text{Units})$ and solve for units.

$$\begin{aligned}\text{Operating income} &= (\text{Price} \times \text{Units}) - (\text{Unit variable cost} \times \text{Units}) - \text{Fixed costs}\\ (0.2)(\$20)\text{Units} &= (\$20 \times \text{Units}) - (\$12 \times \text{Units}) - \$64{,}000\\ \$4 \times \text{Units} &= \$64{,}000\\ \text{Units} &= 16{,}000\end{aligned}$$

The income statement is as follows:

Sales (16,000 × $20)	$320,000
Less: Variable expenses (16,000 × $12)	192,000
Contribution margin	128,000
Less: Fixed expenses	64,000
Operating income	$ 64,000

$$\text{Operating income/Sales} = \$64{,}000/\$320{,}000 = 0.20, \text{ or } 20\%$$

5. The margin of safety is $10{,}000 - 8{,}000 = 2{,}000$ units, or $40,000 in sales revenues.
6. $$\text{Degree of operating leverage} = \$80{,}000/\$16{,}000 = 5.0$$
$$\text{Percent change in profit} = 15\% \times 5.0 = 75\%$$

II. CVP with Activity-Based Costing

Dory Manufacturing Company produces T-shirts that are screen-printed with the logos of various sports teams. Each shirt is priced at $10. Costs are as follows:

Cost Driver	Unit Variable Cost	Level of Cost Driver
Units sold	$ 5	—
Setups	$450	80
Engineering hours	$ 20	500

Other data:

Total fixed costs (conventional)	$96,000
Total fixed costs (ABC)	50,000

Required:

1. Compute the break-even point in units using conventional analysis.
2. Compute the break-even point in units using activity-based analysis.
3. Suppose that Dory could reduce the setup cost by $150 per setup and could reduce the number of engineering hours needed to 425. How many units must be sold to break even in this case?

Solution:

1. Break-even units = Fixed costs/(Price − Unit variable cost) = $96,000/($10 − $5)
   = 19,200 units
2. Break-even units = [Fixed costs + (Setups × Setup cost) +
   (Engineering hours × Engineering cost)]/
   (Price − Unit variable cost)
   = [$50,000 + ($450 × 80) + ($20 × 500)]/($10 − $5)
   = $96,000/$5
   = 19,200 units
3. Break-even units = [$50,000 + ($300 × 80) + ($20 × 425)]/($10 − $5)
   = $82,500/$5
   = 16,500 units

Key Terms

Break-even point, 101
Common fixed expenses, 111
Contribution margin, 104
Contribution margin ratio, 106
Cost-volume-profit graph, 117
Degree of operating leverage, 124
Direct fixed expenses, 111
Margin of safety, 122
Net income, 102
Operating income, 102
Operating leverage, 123
Profit-volume graph, 116
Relevant range, 119
Sales mix, 112
Sales-revenue approach, 107
Sensitivity analysis, 124
Variable cost ratio, 106

Discussion Questions

1. Explain how CVP analysis can be used for managerial planning.
2. Describe the difference between the units-sold approach to CVP analysis and the sales-revenue approach.
3. Define the term *break-even point*.
4. Explain why contribution margin per unit becomes profit per unit above the break-even point.
5. A restaurant owner who had yet to earn a monthly profit said, "The busier we are, the more we lose." What do you think is happening in terms of contribution margin?
6. What is the variable cost ratio? The contribution margin ratio? How are the two ratios related?
7. If the contribution margin increases from 30 to 35 percent of sales, what will happen to the break-even point, and why will this occur?
8. Suppose a firm with a contribution margin ratio of 0.3 increased its advertising expenses by $10,000 and found that sales increased by $30,000. Was it a good decision to increase advertising expenses? Why is this simple problem an important one for businesspeople to understand?
9. Define the term *sales mix*, and give an example to support your definition.

10. Explain how CVP analysis developed for single products can be used in a multiple-product setting.
11. Why might a multiple-product firm choose to calculate just overall break-even revenue rather than the break-even quantity by product?
12. How do income taxes affect the break-even point and CVP analysis?
13. Explain how a change in sales mix can change a company's break-even point.
14. Define the term *margin of safety*. Explain what is meant by the term *operating leverage*. What impact does an increase in the margin of safety have on risk? What impact does an increase in leverage have on risk?
15. Why does the activity-based costing approach to CVP analysis offer more insight than the conventional approach does?

Cornerstone Exercises

OBJECTIVE 1
CORNERSTONE 3-1

Cornerstone Exercise 3-1 VARIABLE COSTS, CONTRIBUTION MARGIN, CONTRIBUTION MARGIN RATIO

Custom Screenprinting Company plans to sell 8,000 T-shirts at $15 each in the coming year. Product costs include:

Direct materials per T-shirt	$6.00
Direct labour per T-shirt	$1.25
Variable overhead per T-shirt	$0.75
Total fixed factory overhead	$32,000

Variable selling expense is the redemption of a coupon, which averages $1.00 per T-shirt; fixed selling and administrative expense totals $10,000.

Required:

1. Calculate the:
   a. Variable product cost per unit
   b. Total variable cost per unit
   c. Contribution margin per unit
   d. Contribution margin ratio
   e. Total fixed expense for the year
2. Prepare a contribution-margin-based income statement for Custom Screenprinting Company for the coming year.
3. ***What if*** the per unit selling expense increased from $1.00 to $1.75? Calculate the new values for the following:
   a. Variable product cost per unit
   b. Total variable cost per unit
   c. Contribution margin per unit
   d. Contribution margin ratio
   e. Total fixed expense for the year

OBJECTIVE 1
CORNERSTONE 3-2

Cornerstone Exercise 3-2 BREAK-EVEN UNITS, UNITS FOR TARGET PROFIT

Dorion Company makes an in-car navigation system. Next year, Dorion plans to sell 6,000 units at a price of $300 each. Product costs include:

Direct materials	$75
Direct labour	$50
Variable overhead	$12
Total fixed factory overhead	$500,000

Variable selling expense is a commission of 6 percent of price; fixed selling and administrative expense totals $109,000.

Required:

1. Calculate the sales commission per unit sold. Calculate the contribution margin per unit.
2. How many units must Dorion Company sell to break even? Prepare an income statement for the calculated number of units.
3. Calculate the number of units Dorion Company must sell to achieve target operating income (profit) of $333,500.
4. ***What if*** Dorion Company wanted to achieve a target operating income of $314,650? Would the number of units needed increase or decrease compared to your answer in Requirement 3? Compute the number of units needed for the new target operating income.

Cornerstone Exercise 3-3 BREAK-EVEN SALES, SALES FOR TARGET PROFIT

OBJECTIVE 1
CORNERSTONE 3-3
SERVICE

Kalpna Company is a placement agency for temporary nurses. It serves hospitals and clinics throughout the metropolitan area. Kalpna Company believes it will place temporary nurses for a total of 25,000 hours next year. Kalpna charges the hospitals and clinics $75 per hour and has variable costs of $60 per hour (this includes the payment to the nurse). Total fixed costs equal $321,000.

Required:

1. Calculate the contribution margin per unit and the contribution margin ratio.
2. Calculate the sales revenue needed to break even.
3. Calculate the sales revenue needed to achieve a target profit of $100,000.
4. ***What if*** Kalpna had target operating income (profit) of $90,000? Would sales revenue be larger or smaller than the one calculated in Requirement 3. Why? By how much?

Cornerstone Exercise 3-4 AFTER-TAX PROFIT TARGETS

OBJECTIVE 2
CORNERSTONE 3-4

LaFramboise Company wants to earn $420,000 in net (after-tax) income next year. Its product is priced at $480 per unit. Product costs include:

Direct materials	$150
Direct labour	$100
Variable overhead	$25
Total fixed factory overhead	$352,000

Variable selling expense is $45 per unit; fixed selling and administrative expense totals $340,000. LaFramboise has a tax rate of 30 percent.

Required:

1. Calculate the before-tax profit needed to achieve an after-tax target of $420,000.
2. Calculate the number of units that will yield operating income calculated in Requirement 1 above.
3. Prepare an income statement for LaFramboise Company for the coming year based on the number of units computed in Requirement 2.
4. ***What if*** LaFramboise had a 35 percent tax rate? Would the units sold to reach a $420,000 target net income be higher or lower than the units calculated in Requirement 3? Calculate the number of units needed at the new tax rate.

Cornerstone Exercise 3-5 MULTIPLE-PRODUCT BREAK-EVEN AND TARGET PROFIT

OBJECTIVE 1 3
CORNERSTONE 3-5

Sandman Enterprises produces and sells two products: a bedside lamp decorated with comic book characters, and a baby mobile that hangs above a crib and can play lullabies. Sandman plans to sell 30,000 bedside lamps and 20,000 lullaby mobiles in the coming year. Product price and cost information includes:

	Bedside Lamp	Lullaby Mobile
Price	$24	$40
Unit variable cost	$12	$10
Direct fixed cost	$23,600	$45,000

Common fixed selling and administrative expense totals $85,000.

Required:

1. What is the sales mix estimated for next year (calculated to the lowest whole number for each product)?
2. Using the sales mix from Requirement 1, form a package of bedside lamps and lullaby mobiles. How many bedside lamps and lullaby mobiles are sold at break-even?
3. Prepare a contribution-margin-based income statement for Sandman Enterprises based on the unit sales calculated in Requirement 2.
4. ***What if*** Sandman Enterprises wanted to earn operating income equal to $14,400? Calculate the number of bedside lamps and lullaby mobiles that must be sold to earn this level of operating income. (*Hint:* Remember to form a package of bedside lamps and lullaby mobiles based on the sales mix and to first calculate the number of packages to earn operating income of $14,400.)

OBJECTIVE 1 5
CORNERSTONE 3-6
SERVICE

Cornerstone Exercise 3-6 BREAK-EVEN UNITS AND SALES REVENUE, MARGIN OF SAFETY

Dunst and Dafoe Copy Shop (D&D) provides photocopying service. Next year, D&D estimates it will copy 2,400,000 pages at a price of $0.08 each in the coming year. Product costs include:

Direct materials	$0.020
Direct labour	$0.004
Variable overhead	$0.001
Total fixed overhead	$50,000

There is no variable selling expense; fixed selling and administrative expense totals $21,500.

Required:

1. Calculate the break-even point in units.
2. Calculate the break-even point in sales revenue.
3. Calculate the margin of safety in units for the coming year.
4. Calculate the margin of safety in sales revenue for the coming year.
5. What if the total fixed overhead increases to $53,300? Recalculate:
   a. Break-even point in units
   b. Break-even point in sales revenue
   c. Margin of safety in units for the coming year
   d. Margin of safety in sales revenue for the coming year

OBJECTIVE 1 5
CORNERSTONE 3-7

Cornerstone Exercise 3-7 DEGREE OF OPERATING LEVERAGE, PERCENT CHANGE IN PROFIT

Dorval Company is considering two different processes to make its product—process 1 and process 2. Process 1 requires Dorval to manufacture subcomponents of the product in-house. As a result, materials are less expensive, but fixed overhead is higher. Process 2 involves purchasing all subcomponents from outside suppliers. The direct materials costs are higher, but fixed factory overhead is considerably lower. Relevant data for a sales level of 30,000 units follow:

	Process 1	Process 2
Sales	$6,000,000	$6,000,000
Variable expenses	2,700,000	4,200,000
Contribution margin	3,300,000	1,800,000
Less total fixed expenses	1,925,000	600,000
Operating income	$1,375,000	$1,200,000
Unit selling price	$200	$200
Unit variable cost	$90	$140
Unit contribution margin	$110	$60

Required:

1. Compute the degree of operating leverage for each process.
2. Suppose that sales are 30 percent higher than budgeted. By what percentage will operating income increase for each process? What will be the *increase* in operating income for each system? What will be the *total operating income* for each process?
3. ***What if*** unit sales are 10 percent lower than budgeted? By what percentage will operating income decrease for each process? What will be the *total operating income* for each process?

Exercises

Exercise 3-8 CONTRIBUTION MARGIN, BREAK-EVEN UNITS, CONTRIBUTION MARGIN INCOME STATEMENT, MARGIN OF SAFETY

OBJECTIVE 1

Kool-skinz Company manufactures custom-designed skins (covers) for iPods® and other portable MP3 devices. Variable costs are $10.80 per custom skin, the price is $18, and fixed costs are $66,960.

Required:

1. What is the contribution margin for one custom skin?
2. How many custom skins must Kool-skinz Company sell to break even?
3. If Kool-skinz Company sells 12,000 custom skins, what is the operating income?
4. Calculate the margin of safety in units and in sales revenue if 12,000 custom skins are sold.

Exercise 3-9 BREAK-EVEN IN UNITS

OBJECTIVE 1

Shellenberger Company manufactures high-end gas grills. Fixed costs amount to $19,980,000 per year. Variable costs per gas grill are $395, and the average price per gas grill is $950.

Required:

1. How many gas grills must Shellenberger Company sell to break even?
2. If Shellenberger Company sells 41,000 gas grills in a year, what is the operating income?
3. If Shellenberger Company's variable costs increase to $420 per grill while the price and fixed costs remain unchanged, what is the new break-even point? (Round up to the next higher whole unit.)

Exercise 3-10 CONTRIBUTION MARGIN RATIO, BREAK-EVEN SALES REVENUE, SALES REVENUE FOR TARGET PROFIT

OBJECTIVE 1

Parker Pharmaceuticals Inc. plans to sell 500,000 units of anti-venom at an average price of $6 each in the coming year. Total variable costs equal $600,000. Total fixed costs equal $8,000,000.

Required:

1. What is the contribution margin per unit? What is the contribution margin ratio?
2. Calculate the sales revenue needed to break even.
3. Calculate the sales revenue needed to achieve a target profit of $650,000.
4. ***What if*** the average price per unit increased to $7? Recalculate:
   a. Contribution margin per unit
   b. Contribution margin ratio (rounded to four decimal places)
   c. Sales revenue needed to break even
   d. Sales revenue needed to achieve a target profit of $650,000

OBJECTIVE 1 5

Exercise 3-11 BREAK-EVEN IN UNITS, TARGET INCOME, NEW UNIT VARIABLE COST, DEGREE OF OPERATING LEVERAGE, PERCENT CHANGE IN OPERATING INCOME

McDuffy's Inc. has developed a chew-proof dog bed—the McTuffie. Fixed costs are $144,000 per year. The average price for the McTuffie is $32, and the average variable cost is $24 per unit. Currently, McDuffy's produces and sells 20,000 McTuffies.

Required:

1. How many McTuffies must be sold to break even?
2. If McDuffy's wants to earn $46,000 in profit, how many McTuffies must be sold? Prepare a variable-costing income statement to verify your answer.
3. Suppose that McDuffy's would like to lower the break-even units to 12,000. The company does not believe that the price or fixed cost can be changed. Calculate the new unit variable cost that would result in break-even units of 12,000.
4. What is McDuffy's current contribution margin and operating income? Calculate the degree of operating leverage (round your answer to two decimal places). If sales increased by 10 percent next year, what would the percent change in operating income be? What would the new total operating income for next year be?

OBJECTIVE 1 2

SERVICE

Exercise 3-12 BREAK-EVEN FOR A SERVICE FIRM

Sasha Melton owns and operates The Green Belt Company (GBC), which provides live plants and flower arrangements to professional offices. Sasha has fixed costs of $2,380 per month for office/greenhouse rent, advertising, and a delivery van. Variable costs for the plants, fertilizer, pots, and other supplies average $25 per job. GBC charges $60 per month for the average job.

Required:

1. How many jobs must GBC average each month to break even?
2. What is the operating income for GBC in a month with 65 jobs? With 90 jobs?
3. Sasha faces a tax rate equal to 30 percent. How many jobs must Sasha have per month to earn an after-tax income of $980?
4. Suppose that Sasha's fixed costs increase to $2,500 per month and she decides to increase the price to $75 per job. What is the new break-even point in number of jobs per month?

OBJECTIVE 1 5

SERVICE

Exercise 3-13 BREAK-EVEN IN SALES REVENUE, MARGIN OF SAFETY

StarSports Inc. represents professional athletes and movie and television stars. The agency had revenue of $10,780,000 last year, with total variable costs of $5,066,600 and fixed costs of $2,194,200.

Required:

1. What is the contribution margin ratio for StarSports based on last year's data? What is the break-even point in sales revenue?
2. What was the margin of safety for StarSports last year?
3. One of StarSports's agents proposed that the firm begin cultivating high school sports stars around the nation. This proposal is expected to increase revenue by $150,000 per year, with increased fixed costs of $140,000. Is this proposal a good idea? Explain.

OBJECTIVE 1 2

Exercise 3-14 CVP, BEFORE- AND AFTER-TAX TARGETED INCOME

Head-Gear Company produces helmets for bicycle racing. Currently, Head-Gear charges $230 per helmet. Variable costs are $80.50 per helmet, and fixed costs are $1,255,800. The tax rate is 25 percent. Last year, 14,000 helmets were sold.

Required:

1. What is Head-Gear's net income for last year?
2. What is Head-Gear's break-even revenue? (Round to the nearest dollar.)

3. Suppose Head-Gear wants to earn before-tax operating income of $900,000. How many units must be sold? (Round to the nearest unit.)
4. Suppose Head-Gear wants to earn after-tax net income of $650,000. How many units must be sold? (Round to the nearest unit.)
5. Suppose the income tax rate rises to 35 percent. How many units must be sold for Head-Gear to earn after-tax income of $650,000? (Round to the nearest unit.)

Exercise 3-15 CVP, BEFORE- AND AFTER-TAX TARGETED INCOME

OBJECTIVE 1 4

Sara Pacheco is a sophomore in university and earns a little extra money by making beaded key ring accessories. She sells them on Saturday mornings at the local flea market. Sara charges $5 per unit and has unit variable costs (beads, wire rings, etc.) of $2. Her fixed costs consist of small pliers, a glue gun, etc., which cost her $90.

Required:

1. Calculate Sara's break-even units.
2. Prepare a profit-volume graph for Sara.
3. Prepare a cost-volume-profit graph for Sara.

Exercise 3-16 ASSUMPTIONS AND USE OF VARIABLES

OBJECTIVE 1 5

Choose the *best* answer for each of the following multiple-choice questions.

1. Cost-volume-profit analysis includes some simplifying assumptions. Which of the following is **not** one of these assumptions?
   a. Cost and revenues are predictable.
   b. Cost and revenues are linear over the relevant range.
   c. Changes in beginning and ending inventory levels are insignificant in amount.
   d. Sales mix changes are irrelevant.
2. The term *relevant range*, as used in cost accounting, means the range
   a. over which costs may fluctuate
   b. over which cost relationships are valid
   c. of probable production
   d. over which production has occurred in the past 10 years
3. How would the following be used in calculating the number of units that must be sold to earn a targeted operating income?

	Price per Unit	Targeted Operating Income
a.	Denominator	Numerator
b.	Numerator	Numerator
c.	Not used	Denominator
d.	Numerator	Denominator

4. Information concerning Korian Corporation's product is as follows:

Sales	$300,000
Variable costs	240,000
Fixed costs	40,000

   Assuming that Korian increased sales of the product by 20 percent, what should the operating income be?
   a. $20,000
   b. $24,000
   c. $32,000
   d. $80,000
5. The following data apply to Chan Company for last year:

Total variable costs per unit	$3.50
Contribution margin/Sales	30%
Break-even sales (present volume)	$1,000,000

Chan wants to sell an additional 50,000 units at the same selling price and contribution margin. By how much can fixed costs increase to generate additional profit equal to 10 percent of the sales value of the additional 50,000 units to be sold?
a. $50,000
b. $57,500
c. $67,500
d. $125,000

6. Bryan Company's break-even point is 8,500 units. Variable cost per unit is $140, and total fixed costs are $297,500 per year. What price does Bryan charge?
a. $140
b. $35
c. $175
d. cannot be determined from the above data

OBJECTIVE 1 5

Exercise 3-17 CONTRIBUTION MARGIN, CVP, NET INCOME, MARGIN OF SAFETY

Tintique Inc. produces novelty nail polishes. Each bottle sells for $3.84. Variable unit costs are as follows:

Acrylic base	$0.75	Bottle, packing material	$1.15
Pigments	0.38	Selling commission	0.25
Other ingredients	0.35		

Fixed overhead costs are $12,000 per year. Fixed selling and administrative costs are $6,720 per year. Tintique sold 35,000 bottles last year.

Required:

1. What is the contribution margin per unit for a bottle of nail polish? What is the contribution margin ratio?
2. How many bottles must be sold to break even? What is the break-even sales revenue?
3. What was Tintique's operating income last year?
4. What was the margin of safety in revenue?
5. Suppose that Tintique raises the price to $4.00 per bottle, but anticipated sales will drop to 29,800 bottles. What will the new break-even point in units be? Should Tintique raise the price? Explain.

OBJECTIVE 1 5

Exercise 3-18 OPERATING LEVERAGE

Income statements for two different companies in the same industry are as follows:

	Trimax Inc.	Quintex Inc.
Sales	$500,000	$500,000
Less: Variable costs	250,000	100,000
Contribution margin	250,000	400,000
Less: Fixed costs	200,000	350,000
Operating income	$ 50,000	$ 50,000

Required:

1. Compute the degree of operating leverage for each company.
2. Compute the break-even point for each company. Explain why the break-even point for Quintex is higher.
3. Suppose that both companies experience a 50 percent increase in revenues. Compute the percentage change in profits for each company. Explain why the percentage increase in Quintex's profits is so much greater than that of Trimax.

OBJECTIVE 3

Exercise 3-19 CVP ANALYSIS OF MULTIPLE PRODUCTS

Rossi Company produces GPS devices. One model is the GPS-auto, a basic model that is designed to attach to the windshield of a car. Another model, the GPS-marine, has extensive charts of oceans around the world. For the coming year, Rossi expects to sell

80,000 GPS-autos and 5,000 GPS-marines. A segmented income statement for the two products is as follows:

	GPS-Auto	GPS-Marine	Total
Sales	$16,000,000	$3,000,000	$19,000,000
Less: Variable costs	12,000,000	2,000,000	14,000,000
Contribution margin	4,000,000	1,000,000	5,000,000
Less: Direct fixed costs	1,200,000	960,000	2,160,000
Segment margin	$ 2,800,000	$ 40,000	2,840,000
Less: Common fixed costs			1,280,000
Operating income			$ 1,560,000

Required:

1. Compute the number of GPS-autos and GPS-marines that must be sold to break even.
2. Using information only from the total column of the income statement, compute the sales revenue that must be generated for the company to break even. (Round the contribution margin ratio to five significant digits and the sales revenue to the nearest dollar.)

Exercise 3-20 CVP WITH ACTIVITY-BASED COSTING

OBJECTIVE 1 6

Busy-Bee Baking Company produces a variety of breads. The average price of a loaf of bread is $1. Costs are as follows:

Cost Driver	Unit Variable Cost	Level of Cost Driver
Units sold	$0.65	—
Setups	$300	150
Maintenance hours	$15	2,500

Other data:

Total fixed costs (traditional)	$140,000
Total fixed costs (ABC)	57,500

Required:

1. Compute the break-even point in units using conventional analysis.
2. Compute the break-even point in units using activity-based analysis.
3. Suppose that Busy-Bee could reduce the setup cost by $100 per setup and could reduce the number of maintenance hours needed to 1,000. How many units must be sold to break even in this case? (Round answer up to whole units.)

Exercise 3-21 CVP WITH ACTIVITY-BASED COSTING AND MULTIPLE PRODUCTS

OBJECTIVE 1 3 6

Busy-Bee Baking Company produces a variety of breads. The plant manager would like to expand production into sweet rolls as well. The average price of a loaf of bread is $1. Anticipated price for a package of sweet rolls is $1.50. Costs for the new level of production are as follows:

Cost Driver	Unit Variable Cost	Level of Cost Driver
Loaf of bread	$0.65	—
Package of sweet rolls	$0.93	—
Setups	$300	250
Maintenance hours	$15	3,500

Other data:

Total fixed costs (traditional)	$185,000
Total fixed costs (ABC)	57,500

Busy-Bee believes it can sell 600,000 loaves of bread and 200,000 packages of sweet rolls in the coming year.

Required:

1. Prepare a contribution-margin-based income statement for next year. Be sure to show sales and variable costs by product and in total.
2. Compute the break-even sales for the company as a whole using conventional analysis.
3. Compute the break-even sales for the company as a whole using activity-based analysis.
4. Compute the break-even units of each product in units. Does it matter whether you use conventional analysis or activity-based analysis? Why or why not?
5. Suppose that Busy-Bee could reduce the setup cost by $100 per setup and could reduce the number of maintenance hours needed to 1,000. How many units of each product must be sold to break even in this case? (Round answers up to whole units.)

Problems

OBJECTIVE 3

Problem 3-22 USING A COMPUTER SPREADSHEET TO SOLVE MULTIPLE-PRODUCT BREAK-EVEN, VARYING SALES MIX

More-Power Company has projected sales of 75,000 regular sanders and 30,000 mini-sanders for next year. The projected income statement is as follows:

	Regular Sander	Mini-Sander	Total
Sales	$3,000,000	$1,800,000	$4,800,000
Less: Variable expenses	1,800,000	900,000	2,700,000
Contribution margin	1,200,000	900,000	2,100,000
Less: Direct fixed expenses	250,000	450,000	700,000
Product margin	$ 950,000	$ 450,000	1,400,000
Less: Common fixed expenses			600,000
Operating income			$ 800,000

Required:

1. Set up the given income statement on a spreadsheet (e.g., Excel™). Then substitute the following sales mixes and calculate operating income. Be sure to print the results for each sales mix (a through d).

	Regular Sander	Mini-Sander
a.	75,000	37,500
b.	60,000	60,000
c.	30,000	90,000
d.	30,000	60,000

2. Calculate the break-even units for each product for each of the preceding sales mixes.

OBJECTIVE 1

Problem 3-23 CONTRIBUTION MARGIN, UNIT AMOUNTS

Consider the following information on four independent companies.

	A	B	C	D
Sales	$10,000	$?	$?	$9,000
Less: Variable costs	8,000	11,700	9,750	?
Contribution margin	2,000	7,800	?	?
Less: Fixed costs	?	4,500	?	900
Operating income	$ 1,000	$?	$8,000	$2,850

	A	B	C	D
Units sold	?	1,300	300	500
Price/Unit	$4	$?	$130	$?
Variable cost/Unit	$?	$9	$?	$?
Contribution margin/Unit	$?	$6	$?	$?
Contribution margin ratio	?	?	75%	?
Break-Even in units	?	?	?	?

Required:

Calculate the correct amount for each question mark. Be sure to round any fractional break-even units *up* to the next whole number.

Problem 3-24 BREAK-EVEN IN SALES REVENUE, VARIABLE-COSTING RATIO, CONTRIBUTION MARGIN RATIO, MARGIN OF SAFETY

OBJECTIVE 1 2 5

SERVICE

Furyk Company runs a driving range and golf shop. The budgeted income statement for the coming year is as follows.

Sales	$800,000
Less: Variable expenses	344,000
Contribution margin	456,000
Less: Fixed expenses	310,000
Income before taxes	146,000
Less: Income taxes	51,100
Net income	$ 94,900

Required:

1. What is Furyk's variable cost ratio? Its contribution margin ratio?
2. Suppose Furyk's actual revenues are $150,000 greater than budgeted. By how much will before-tax profits increase? Give the answer without preparing a new income statement.
3. How much sales revenue must Furyk earn in order to break even? What is the expected margin of safety? (Round your answers to the nearest dollar.)
4. How much sales revenue must Furyk generate to earn a before-tax profit of $120,000? An after-tax profit of $120,000? (Round your answers to the nearest dollar.) Prepare a contribution margin income statement to verify the accuracy of your last answer.

Problem 3-25 CHANGES IN BREAK-EVEN POINTS WITH CHANGES IN UNIT PRICES

OBJECTIVE 1 5

Cabrera Inc. produces and sells bobblehead dolls. Last year, Cabrera sold 156,250 units. The income statement for Cabrera Inc. for last year is as follows:

Sales	$625,000
Less: Variable expenses	343,750
Contribution margin	281,250
Less: Fixed expenses	180,000
Operating income	$101,250

Required:

1. Compute the break-even point in units and in revenues. Compute the margin of safety in sales revenue for last year.
2. Suppose that the selling price decreases by 10 percent. Will the break-even point increase or decrease? Recompute the break-even point in units. (Round up to the next whole unit.)
3. Suppose that the variable cost per unit decreases by $0.25. Will the break-even point increase or decrease? Recompute the break-even point in units. (Round up to the next whole unit.)
4. Can you predict whether the break-even point increases or decreases if both the selling price and the unit variable cost decrease? Recompute the break-even point in

units incorporating both of the changes in Requirements 2 and 3. (Round up to the next whole unit.)

5. Assume that total fixed costs increase by $50,000. (Assume no other changes from the original data.) Will the break-even point increase or decrease? Recompute it. (Round up to the next whole unit.)

OBJECTIVE 1 2 5

Problem 3-26 BREAK-EVEN, AFTER-TAX TARGET INCOME, MARGIN OF SAFETY, OPERATING LEVERAGE

Faldo Company produces a single product. The projected income statement for the coming year, based on sales of 200,000 units, is as follows:

Sales	$2,000,000
Less: Variable costs	1,400,000
Contribution margin	600,000
Less: Fixed costs	450,000
Operating income	$ 150,000

Required:

1. Compute the unit contribution margin and the units that must be sold to break even. Suppose that 30,000 units are sold above the break-even point. What is the profit?
2. Compute the contribution margin ratio and the break-even point in dollars. Suppose that revenues are $200,000 greater than expected. What would the total profit be?
3. Compute the margin of safety in sales revenue.
4. Compute the operating leverage. Compute the new profit level if sales are 20 percent higher than expected.
5. How many units must be sold to earn a profit equal to 10 percent of sales?
6. Assume the income tax rate is 40 percent. How many units must be sold to earn an after-tax profit of $180,000?

OBJECTIVE 1 2 5

Problem 3-27 BASIC CVP CONCEPTS

Katayama Company produces a variety of products. One division makes neoprene wetsuits. The division's projected income statement for the coming year is as follows:

Sales (65,000 units)	$15,600,000
Less: Variable expenses	8,736,000
Contribution margin	6,864,000
Less: Fixed expenses	4,012,000
Operating income	$ 2,852,000

Required:

1. Compute the contribution margin per unit, and calculate the break-even point in units. Repeat, using the contribution margin ratio.
2. The divisional manager has decided to increase the advertising budget by $140,000 and cut the average selling price to $200. These actions will increase sales revenues by $1 million. Will this improve the division's financial situation? Prepare a new income statement to support your answer.
3. Suppose sales revenues exceed the estimated amount on the income statement by $612,000. Without preparing a new income statement, determine by how much profits are underestimated.
4. How many units must be sold to earn an after-tax profit of $1.254 million? Assume a tax rate of 34 percent. (Round your answer up to the next whole unit.)
5. Compute the margin of safety in dollars based on the given income statement.
6. Compute the operating leverage based on the given income statement. (Round to three significant digits.) If sales revenues are 20 percent greater than expected, what is the percentage increase in profits?

Problem 3-28 CVP ANALYSIS: SALES-REVENUE APPROACH, PRICING, AFTER-TAX TARGET INCOME

OBJECTIVE 2 5

SERVICE

Mahan Consulting is a service organization that specializes in the design, installation, and servicing of mechanical, hydraulic, and pneumatic systems. For example, some manufacturing firms, with machinery that cannot be turned off for servicing, need some type of system to lubricate the machinery during use. To deal with this type of problem for a client, Mahan designed a central lubricating system that pumps lubricants intermittently to bearings and other moving parts.

The operating results for the firm for the previous year are as follows:

Sales	$974,880
Less: Variable expenses	534,234
Contribution margin	440,646
Less: Fixed expenses	264,300
Operating income	$176,346

In the coming year, Mahan expects variable costs to increase by 4 percent and fixed costs by 3 percent.

Required:

1. What is the contribution margin ratio (rounded to three significant digits) for the previous year?
2. Compute Mahan's break-even point for the previous year in dollars.
3. Suppose that Mahan would like to see a 6 percent increase in operating income in the coming year. What percent (on average) must Mahan raise its bids to cover the expected cost increases and obtain the desired operating income? Assume that Mahan expects the same mix and volume of services in both years.
4. In the coming year, how much revenue must be earned for Mahan to earn an after-tax profit of $175,000? Assume a tax rate of 40 percent.

Problem 3-29 MULTIPLE PRODUCTS, BREAK-EVEN ANALYSIS, OPERATING LEVERAGE, SEGMENTED INCOME STATEMENTS

OBJECTIVE 3 5

Ironjay Inc. produces two types of weight-training equipment: the Jay-flex (a weight machine that allows the user to perform a number of different exercises) and a set of free weights. Ironjay sells the Jay-flex to sporting goods stores for $200. The free weights sell for $75 per set. The projected income statement for the coming year follows:

Sales	$600,000
Less: Variable expenses	390,000
Contribution margin	210,000
Less: Fixed expenses	157,500
Operating income	$ 52,500

The owner of Ironjay estimates that 40 percent of the sales revenues will be produced by sales of the Jay-flex, with the remaining 60 percent by free weights. The Jay-flex is also responsible for 40 percent of the variable expenses. Of the fixed expenses, one-third are common to both products, and one-half are directly traceable to the Jay-flex line.

Required:

1. Compute the sales revenue that must be earned for Ironjay to break even.
2. Compute the number of Jay-flex machines and free weight sets that must be sold for Ironjay to break even.
3. Compute the degree of operating leverage for Ironjay. Now, assume that the actual revenues will be 40 percent higher than the projected revenues. By what percentage will profits increase with this change in sales volume?
4. Ironjay is considering adding a new product—the Jay-rider. The Jay-rider is a cross between a rowing machine and a stationary bicycle. For the first year, Ironjay estimates that the Jay-rider will cannibalize 600 units of sales from the Jay-flex. Sales of free-weight sets will remain unchanged. The Jay-rider will sell for $180 and have

variable costs of $140. The increase in fixed costs to support manufacture of this product is $5,700. Compute the number of Jay-flex machines, free-weight sets, and Jay-riders that must be sold for Ironjay to break even. For the coming year, is the addition of the Jay-rider a good idea? Why or why not? Why might Ironjay choose to add the Jay-rider anyway?

OBJECTIVE 1 5

Problem 3-30 BREAK-EVEN IN UNITS AND SALES DOLLARS, MARGIN OF SAFETY

Dragon Company produces a single product. Last year's income statement is as follows:

Sales (20,000 units)	$1,218,000
Less: Variable costs	812,000
Contribution margin	406,000
Less: Fixed costs	300,000
Operating income	$ 106,000

Required:

1. Compute the break-even point in units and sales revenue.
2. What was the margin of safety for Dragon Company last year?
3. Suppose that Dragon Company is considering an investment in new technology that will increase fixed costs by $250,000 per year, but will lower variable costs to 45 percent of sales. Units sold will remain unchanged. Prepare a budgeted income statement assuming Dragon makes this investment. What is the new break-even point in units, assuming the investment is made?

OBJECTIVE 1 6

Problem 3-31 CVP ANALYSIS, IMPACT OF ACTIVITY-BASED COSTING

Salem Electronics currently produces two products: a programmable calculator and a tape recorder. A recent marketing study indicated that consumers would react favourably to a radio with the Salem brand name. Owner Kenneth Booth was interested in the possibility. Before any commitment was made, however, Kenneth wanted to know what the incremental fixed costs would be and how many radios must be sold to cover these costs.

In response, Betty Johnson, the marketing manager, gathered data for the current products to help in projecting overhead costs for the new product. The overhead costs based on 30,000 direct labour hours follow. (The high-low method using direct labour hours as the independent variable was used to determine the fixed and variable costs.)

	Fixed	Variable
Materials handling	$ —	$18,000
Power	—	22,000
Engineering	100,000	—
Machine costs	30,000*	80,000
Inspection	40,000	—
Setups	60,000	—

*All depreciation.

The following activity data were also gathered:

	Calculators	Recorders
Units produced	20,000	20,000
Direct labour hours	10,000	20,000
Machine hours	10,000	10,000
Material moves	120	120
Kilowatt-hours	1,000	1,000
Engineering hours	4,000	1,000
Hours of inspection	700	1,400
Number of setups	20	40

Betty was told that a plantwide overhead rate was used to assign overhead costs based on direct labour hours. She was also informed by engineering that if 20,000 radios were

produced and sold (her projection based on her marketing study), they would have the same activity data as the recorders (use the same direct labour hours, machine hours, set-ups, and so on).

Engineering also provided the following additional estimates for the proposed product line:

Prime costs per unit	$ 18
Depreciation on new equipment	18,000

Upon receiving these estimates, Betty did some quick calculations and became quite excited. With a selling price of $26 and just $18,000 of additional fixed costs, only 4,500 units would have to be sold to break even. Since Betty was confident that 20,000 units could be sold, she was prepared to strongly recommend the new product line.

Required:

1. Reproduce Betty's break-even calculation using conventional cost assignments. How much additional profit would be expected under this scenario, assuming that 20,000 radios were sold?
2. Using an activity-based costing approach, calculate the break-even point and the incremental profit that would be earned on sales of 20,000 units.
3. Explain why the CVP analysis done in Requirement 2 is more accurate than the analysis done in Requirement 1. What recommendation would you make?

Problem 3-32 ABC AND CVP ANALYSIS: MULTIPLE PRODUCTS

OBJECTIVE 3 6

Good Scent Inc. produces two colognes: Rose and Violet. Of the two, Rose is more popular. Data concerning the two products follow:

	Rose	Violet
Expected sales (in cases)	50,000	10,000
Selling price per case	$100	$80
Direct labour hours	36,000	6,000
Machine hours	10,000	3,000
Receiving orders	50	25
Packing orders	100	50
Material cost per case	$50	$43
Direct labour cost per case	$10	$7

The company uses a conventional costing system and assigns overhead costs to products using direct labour hours. Annual overhead costs follow. They are classified as fixed or variable with respect to direct labour hours.

	Fixed	Variable
Direct labour benefits	$ —	$200,000
Machine costs	200,000*	262,000
Receiving department	225,000	—
Packing department	125,000	—
Total costs	$550,000	$462,000

*All depreciation.

Required:

1. Using the conventional approach, compute the number of cases of Rose and the number of cases of Violet that must be sold for the company to break even.
2. Using an activity-based approach, compute the number of cases of each product that must be sold for the company to break even.

CMA Problems

OBJECTIVE 1 5

CMA Problem 3-1 BREAK-EVEN IN SALES REVENUE*

SERVICE

Big Blue Motors Inc. employs 24 sales personnel to market its line of luxury automobiles. The average car sells for $85,000, and a 6 percent commission is paid to the salesperson. Big Blue Motors is considering a change to the commission arrangement where the company would pay each salesperson a salary of $1,600 per month plus a commission of 2 percent of the sales made by that salesperson. What is the amount of total monthly car sales at which Big Blue Motors would be indifferent as to which plan to select? *(CMA adapted)*

OBJECTIVE 1 2 5

CMA Problem 3-2 BREAK-EVEN IN UNITS, AFTER-TAX TARGET INCOME, CVP ASSUMPTIONS*

Shapiro Company manufactures and sells adjustable canopies that attach to motor homes and trailers. The market covers both new unit purchases as well as replacement canopies. Shapiro developed its 2013 business plan based on the assumption that canopies would sell at a price of $400 each. The variable costs for each canopy were projected at $200, and the annual fixed costs were budgeted at $120,000. Shapiro's after-tax profit objective was $225,000; the company's effective tax rate is 40 percent.

While Shapiro's sales usually rise during the second quarter, the May financial statements reported that sales were not meeting expectations. For the first five months of the year, only 350 units had been sold at the established price, with variable costs as planned, and it was clear that the 2013 after-tax profit projection would not be reached unless some actions were taken. Shapiro's president assigned a management committee to analyze the situation and develop several alternative courses of action. The following mutually exclusive alternatives, labelled A, B, and C, were presented to the president:

A. Lower the variable costs per unit by $25 through the use of less expensive materials and slightly modified manufacturing techniques. The sales price will also be reduced by $30, and sales of 2,200 units for the remainder of the year are forecast.
B. Reduce the sales price by $40. The sales organization forecasts that with the significantly reduced sales price, 2,700 units can be sold during the remainder of the year. Total fixed and variable unit costs will stay as budgeted.
C. Cut fixed costs by $10,000, and lower the sales price by 5 percent. Variable costs per unit will be unchanged. Sales of 2,000 units are expected for the remainder of the year.

Required:

1. Determine the number of units that Shapiro Company must sell in order to break even assuming no changes are made to the selling price and cost structure.
2. Determine the number of units that Shapiro Company must sell in order to achieve its after-tax profit objective.
3. Determine which one of the alternatives Shapiro Company should select to achieve its annual after-tax profit objective. Be sure to support your selection with appropriate calculations.
4. The precision and reliability of CVP analysis are limited by several underlying assumptions. Identify at least four of these assumptions. *(CMA adapted)*

OBJECTIVE 2 5

CMA Problem 3-3 BREAK-EVEN IN SALES REVENUE, CHANGES IN VARIABLES*

Carmichael Corporation is in the process of preparing next year's budget. The pro forma income statement for the current year is as follows:

Sales		$1,800,000
Cost of sales:		
Direct materials	$250,000	
Direct labour	180,000	
Variable overhead	106,000	
Fixed overhead	100,000	636,000
Gross profit		1,164,000

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Selling and administrative expenses:		
Variable	$400,000	
Fixed	350,000	750,000
Operating income		$ 414,000

Required:

1. What is the break-even sales revenue (rounded to the nearest dollar) for Carmichael Corporation for the current year?
2. For the coming year, the management of Carmichael Corporation anticipates an 8 percent increase in variable costs and a $60,000 increase in fixed expenses. What is the break-even point in dollars for next year? *(CMA adapted)*

CMA Problem 3-4 AFTER-TAX TARGET INCOME, PROFIT ANALYSIS*

OBJECTIVE 2 3 5

X-Cee-Ski Company recently expanded its manufacturing capacity, which will allow it to produce up to 21,000 pairs of cross-country skis of the mountaineering model or the touring model. The Sales Department assures management that it can sell between 9,000 and 14,000 pairs of either product this year. Because the models are very similar, X-Cee-Ski will produce only one of the two models.

The following information was compiled by the Accounting Department:

	Per-Unit (Pair) Data	
	Mountaineering	Touring
Selling price	$180	$120
Variable costs	130	90

Fixed costs will total $320,000 if the mountaineering model is produced but will be only $220,000 if the touring model is produced. X-Cee-Ski is subject to a 40 percent income tax rate.

Required:

1. If X-Cee-Ski Company desires an after-tax net income of $48,000, how many pairs of touring model skis will the company have to sell?
2. Suppose that X-Cee-Ski Company decided to produce only one model of skis. What is the total sales revenue at which X-Cee-Ski Company would make the same profit or loss regardless of the ski model it decided to produce?
3. If the Sales Department could guarantee the annual sale of 12,000 pairs of either model, which model would the company produce, and why? *(CMA adapted)*

CMA Problem 3-5 BREAK-EVEN IN UNITS*

OBJECTIVE 1

SERVICE

Don Masters and two of his colleagues are considering opening a law office in a large metropolitan area that would make inexpensive legal services available to those who could not otherwise afford these services. The intent is to provide easy access for their clients by having the office open 360 days per year, 16 hours each day from 7:00 a.m. to 11:00 p.m. The office would be staffed by a lawyer, paralegal, legal secretary, and clerk-receptionist for each of the two 8-hour shifts.

In order to determine the feasibility of the project, Don hired a marketing consultant to assist with market projections. The results of this study show that if the firm spends $500,000 on advertising the first year, the number of new clients expected each day would have the following probability distribution:

Number of New Clients per Day	Probability
20	0.10
30	0.30
55	0.40
85	0.20

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Don and his associates believe these numbers are reasonable and are prepared to spend the $500,000 on advertising. Other pertinent information about the operation of the office is as follows.

The only charge to each new client would be $30 for the initial consultation. All cases that warranted further legal work would be accepted on a contingency basis with the firm earning 30 percent of any favourable settlements or judgments. Don estimates that 20 percent of new client consultations will result in favourable settlements or judgments averaging $2,000 each. Repeat clients are not expected during the first year of operations.

The hourly wages of the staff are projected to be $25 for the lawyer, $20 for the paralegal, $15 for the legal secretary, and $10 for the clerk-receptionist. Fringe benefit expenses will be 40 percent of the wages paid. A total of 400 hours of overtime is expected for the year; this will be divided equally between the legal secretary and the clerk-receptionist positions. Overtime will be paid at one and one-half times the regular wage, and the fringe benefit expense will apply to the full wages.

Don has located 6,000 square metres of suitable office space, which rents for $28 per square metre annually. Associated expenses will be $22,000 for property insurance and $32,000 for utilities.

It will be necessary for the group to purchase malpractice insurance, which is expected to cost $180,000 annually. The initial investment in office equipment will be $60,000; this equipment has an estimated useful life of four years. The cost of office supplies has been estimated to be $4 per expected new client consultation.

Required:

1. Determine how many new clients must visit the law office being considered by Don Masters and his colleagues in order for the venture to break even during its first year of operations.
2. Using the information provided by the marketing consultant, determine if it is feasible for the law office to achieve break-even operations. *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

- ➤1 Differentiate the cost accounting systems of service and manufacturing firms and of unique and standardized products.
- ➤2 Discuss the interrelationship of cost accumulation, cost measurement, and cost assignment.
- ➤3 Identify the source documents used in job-order costing.
- ➤4 Describe the cost flows associated with job-order costing, and prepare the journal entries.
- ➤5 Explain how activity-based costing is applied to job-order costing.
- ➤6 Explain how spoiled units are accounted for in a job-order costing system.

CHAPTER 4

Job-Order Costing Systems

Now that we have an understanding of basic cost terminology, we need to look more closely at the system that the firm sets up to account for costs. In other words, we need to determine how we accumulate costs, how to measure/classify them, and then how to assign them to units manufactured or units of service delivered.

Manufacturing Firms versus Service Firms

OBJECTIVE ➤1
Differentiate the cost accounting systems of service and manufacturing firms and of unique and standardized products.

In general, a firm's cost management system mirrors the production process. A cost management system modelled after the production process allows managers to better monitor the economic performance of the firm. A production process may yield a tangible product or a service. Those products or services may be similar in nature or unique. These characteristics of the production process determine the best approach for developing a cost management system.

Manufacturing involves combining direct materials, direct labour, and overhead to produce a new product. The good produced is tangible and can be inventoried and

transported from the plant to the customer. A service is characterized by its intangible nature. It is not separable from the customer and cannot be inventoried. Traditional cost accounting has emphasized manufacturing and virtually ignored services. Now, more than ever, that approach will not do. Our economy has become increasingly service oriented. Managers must be able to track the costs of services rendered just as precisely as they track the costs of goods manufactured. In fact, a company's controller may find it necessary to cost both goods and services as managers take an internal customer approach.

The range of manufacturing and service firms can be represented by a continuum as shown in Exhibit 4-1. The pure service, shown at the left, involves no raw materials and no tangible item for the customer. There are few pure services. Perhaps an example would be an Internet cafe. In the middle of the continuum, and still very much a service, is a beauty salon, which uses direct materials such as hair spray and styling gel. At the other end of the continuum is the manufactured product. Examples include automobiles, cereals, cosmetics, and drugs. Even these, however, often have a service component. For example, a prescription drug must be prescribed by a physician and dispensed by a licensed pharmacist. Automobile dealers stress the continuing service associated with their cars. And what about fast food? Does **Second Cup** provide a product or a service? There are elements of both.

Four areas in which services differ from products are intangibility, inseparability, heterogeneity, and perishability. **Intangibility** refers to the nonphysical nature of services as opposed to products. **Inseparability** means that production and consumption are inseparable for services. **Heterogeneity** refers to the greater chances for variation in the performance of services than in the production of products.

Perishability means that services cannot be inventoried but must be consumed when performed. These differences affect the types of information needed for planning, control, and decision making in the production of services. Exhibit 4-2 illustrates the features associated with the production of services and their interface with the cost management system.

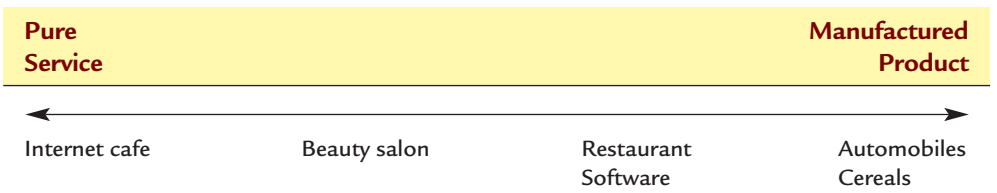
Intangibility

Intangibility of services leads to a major difference in the accounting for services as opposed to products. A service company cannot inventory the service and therefore has a minimal to moderate inventory of supplies. A manufacturing company has inventories of raw materials, supplies, work in process, and finished goods. Because of the significance and complexity of inventories in manufacturing, we will spend more time on manufacturing companies in accounting for the cost of inventories.

Service companies typically rank lower than manufacturing companies in ratings of customer satisfaction.[1] An important reason for this is that service firms have a greater degree of heterogeneity of labour. Service firms are keenly aware of the importance of human resources; the service is provided by people. A key assumption of microeconomics is the homogeneity of labour. That is, one direct labourer is assumed to be identical to another. This assumption is the basis of labour standards in standard costing. Service companies know that one worker is not identical to another.

Exhibit 4-1

Continuum of Services and Manufactured Products



[1] Jaclyn Fierman, "Americans Can't Get No Satisfaction," *Fortune* (December 11, 1995): 186–194.

Exhibit 4-2

Features of Service Firms and Their Interface with the Cost Management System

Feature*	Relationship to Business	Impact on Cost Management System
Intangibility	Services cannot be stored.	There are no inventory accounts.
	Services cannot be protected through patents.	There is a stronger need for an ethical code of conduct.
	Services cannot readily be displayed or communicated.	
	It is more difficult to set prices.	Costs must be related to entire organization.
Inseparability	Consumer is involved in production.	Costs are accounted for by customer type.
	Other consumers are involved in production.	
	Centralized mass production of services is difficult.	System must be generated to encourage consistent quality.
Heterogeneity	Standardization and quality control are difficult.	Productivity measurement is ongoing. TQM is critical.
Perishability	Service benefits expire quickly.	There are no inventories.
	Service may be repeated often for one customer.	There needs to be a standardized system to handle repeat customers.

*First two columns adapted from Valarie Zeithaml, A. Parasuraman, and Leonard L. Berry, "Problems and Strategies in Services Marketing," *Journal of Marketing* 49 (Spring 1985): 34–46.

For example, **Canada's Wonderland** hires "backstage employees" and "on-stage employees." The backstage employees may do maintenance, sew costumes, and work in personnel, but they do not work with the paying public (guests). On-stage employees, hired both for their particular skills and for their ability to interact well with people, work directly with the guests.

A further aspect of labour heterogeneity is that a worker is not the same from one day to the next. Workers can be affected by the job undertaken, the mix of other individuals with whom they work, their education and experience, and personal factors such as health and home life. These factors make the provision of a consistent level of service difficult. The measurement of productivity and quality in a service company must be ongoing and sensitive to these factors.

Inseparability

Inseparability means that differences in customers affect the service firm more than the manufacturing firm. When **Proctor-Silex®** sells a toaster, the mood and personal qualities of the customer are irrelevant. When **Toronto-Holland Orthopedic and Arthritic Centre** sells a service to a customer, however, the disposition of the customer may affect the amount of service required as well as the quality of the service rendered. Inseparability also means that customers evaluate services differently from products. As a result, service companies may need to spend more money on some resources and less on others than would be necessary in a manufacturing plant. For example, consumers may use price and physical facilities as the major cues to service quality. Service firms, then, tend to incur higher costs for attractive places of business than do manufacturing firms. Your initial impression of a manufacturing plant may be how large, noisy, and dingy it is. Floors are concrete; the ceiling is typically unfinished. In short, it is not a pretty sight. However, as long as a high-quality product is made, the consumer does not care. This is very different from most consumers' attitudes toward the service environment. Banks, doctors' offices, and restaurants are

pleasant places, tastefully decorated, and filled with plants. This is cost effective to the extent that customers are drawn to such an environment to conduct business. In addition, the environment may allow the service firm to charge a higher price—signalling its higher quality.

Perishability of services is very similar to intangibility. For example, there are no work-in-process or finished goods inventories of services. However, there is a subtle distinction between intangibility and perishability that merits discussion. A service is perishable if the effects are short term. Not all services fall into this category. Plastic surgery is not perishable, but haircuts are. The impact on cost management is that perishable services require systems to easily handle repeat customers. The repetitive nature of the service also leads us to the use of standardized processes and costing. Examples are financial services (e.g., cheque clearing by banks), janitorial services, and beauty and barber shops.

ETHICS Customers may perceive greater risk when buying services than when buying products. Ethics are important here. The internal accountant who is responsible for gathering data on service quality must accurately report the bad news as well as the good. A customer who has been stung once by misleading advertising or by a firm's failure to deliver the promised performance will be loathe to try that firm again. A manufacturer can offer a warranty or product replacement. But the service firm must consider the customer's wasted time. Therefore, the service firm must be especially careful to avoid promising more than can or will be delivered.◆

Consider the example of **Lexus** which discovered a defect shortly after introducing the car into the United States. Lexus dealers contacted each buyer personally and arranged for loaner cars while the defect was being fixed. In the case of buyers who lived far from a dealership, Lexus brought the repair people to the buyers. More recently, Lexus discovered a larger transmission problem and immediately swapped out the affected cars for new cars.[2] Contrast this experience with service issues experienced by many GM buyers, who must deal with several layers of automotive hierarchy in order to get a defect repaired. Clearly, Lexus understood the value of customers' time in arranging the service.

Service companies are particularly interested in planning and control techniques that apply to their special types of firms. Productivity measurement and quality control are very important. Pricing may involve different considerations for the service firm.

The important point is that service and manufacturing companies may have different needs for accounting data and techniques. It is important for the accountant to be aware of relevant differences in order to provide appropriate support, and to be cross-functionally trained.

McDonald's is an example of both a manufacturing and a service company. In the kitchen, McDonald's runs a production line. The product is rigidly consistent. Each hamburger contains the same amount of meat, mustard, ketchup, and pickles. The buns are identical. The burgers are cooked the prescribed amount of time to a set temperature. They are wrapped in a methodical manner and join other burgers in the warming bin. Standard cost accounting techniques work well for this phase, and McDonald's uses them. At the counter, however, the company becomes a service organization. Customers want their orders taken and filled quickly and correctly. In addition, they want pleasant service and maybe some help finding certain items on the menu. Clean restrooms are critical. McDonald's emphasizes nonfinancial measures of performance for service areas: counter customers are to be served within 60 seconds; drive-through customers are to be served within 90 seconds; restrooms are to be checked and cleaned at least once an hour.

[2] Bill Taylor, "More Lessons from Lexus—Why It Pays to Do the Right Thing." Harvard Business Publishing, December 12, 2007. http://blogs.harvardbusiness.org/taylor/2007/12/more_lessons_from_lexuswhy_it.html (Accessed May 28, 2009).

Heterogeneity versus Standardized Products and Services

A second way of characterizing products and services is according to the degree of uniqueness. If a firm produces unique products in small batches, and if those products incur different costs, then the firm must keep track of the costs of each product or batch. This is referred to as a job-order costing system, the focus of this chapter. At the other extreme, the company may make many identical units of the same product. Since the units are the same, the costs of each unit are also the same. Accounting for the costs of the identical units is relatively simple and is referred to as process costing, examined in Chapter 5.

It is important to note that the uniqueness of the products (or units) for cost accounting purposes relates to unique costs. Consider a large construction company that builds houses in developments across southern Ontario. While the houses are based on several standard models, buyers can customize their houses by selecting different types of brick, tile, carpet, and so on. However, these selections are taken from a set menu of choices. While one house is painted white and its neighbour house is painted green, the cost is the same. However, if different selections have different costs, then those costs must be accounted for separately. Thus, if one home buyer selects a whirlpool tub while another selects a standard model, the different cost of the two tubs must be tracked to the correct house. A builder has to offer choices to clients but also keep track of the costs of each choice. A production process that appears to produce similar products may incur different costs for each product. In this type of situation, the firm should track costs using a job-order costing system.

Both service and manufacturing firms use the job-order costing approach. Custom cabinet makers and home builders manufacture unique products, which must be accounted for using a job-order costing approach. Dental and medical services also use job-order costing. The costs associated with a simple dental filling clearly differ from those associated with a root canal. Printing, automotive repair, and appliance repair are also services using job-order costing.

Firms in process industries mass-produce large quantities of similar, or homogeneous, products. Each product is essentially indistinguishable from its companion product. Examples of process manufacturers include food, cement, petroleum, and chemical firms. The important point here is that the cost of one unit of product is identical to the cost of another. Therefore, service firms can also use a process-costing approach. Discount stockbrokers, for example, incur much the same cost to execute a customer order for one stock as for another; cheque-clearing departments of banks incur a uniform cost to clear a cheque, no matter the value of the cheque or to whom it is written.

A third type of costing system is operation costing. **Operation costing** is a hybrid of job-order and process costing. Units within a batch are the same and can be accounted for using a process approach. However, each batch is different from other batches and the costs of the batches are handled separately in a job-order costing manner. Some clothing and electronics firms use operation costing.

Interestingly, companies are gravitating toward job-order costing because of the increased variety of products and increased demand for small orders and prototypes.

An excellent example is Etobicoke-based apparel company **Fairweather Ltd**. The company manufactures women's and girls' nightware, foundation garments, lingerie, and loungewear. Fairweather can handle small and bigger orders. It emphasizes on-time delivery and fills orders quickly. The actual products that customers receive are the same as the samples the company uses for marketing purposes. Flexible manufacturing of specialized products leads Fairweather into an approximate job-order costing environment.

Perishability

When a client misses an appointment with a doctor, dentist, hairdresser, or lawyer, that time can never be recaptured. When a commercial airliner flies with empty seats, or hotel rooms are empty, or theatre tickets go unsold, the potential for sales/profits vanishes. The perishability of these services creates difficulties in balancing supply and

demand. Demand may be seasonal; for example, Christmas may be the peak season for retailers, or summer the peak season for hotels and airlines (i.e., when most people take vacation). When demand fluctuates and capacity is fixed, it can be a challenge to maintain high performance levels. During tax season, for example, tax preparers may not have the time to provide clients with the same personalized attention as at other times of the year. Supply/demand issues for goods can usually be solved through production scheduling and inventory management; this is not the case with services. Because of perishability, inventory is nil and creative thinking is necessary in order to better utilize available capacity.

Canada's largest theatre chain is **Cineplex Entertainment**. The movie theatre industry today is facing several challenges, the main one being that, like many other service-based businesses, Cineplex must deal with the fact that its services are both intangible and perishable. Cineplex has tackled the first challenge by making the theatre experience more tangible. The company is remodelling its complexes, upgrading their projection and sound systems, and installing more comfortable seating. It is also developing nonfilm activities to turn its venues into entertainment destinations. A new 4,180-square-metre cinema complex in Oakville, for example, offers a six-lane bowling alley, billiards, party rooms, a Kids Club, babysitting services, and private VIP rooms. All of this is in addition to 12 movie screens. In partnership with Scotiabank, Cineplex has also launched a loyalty program. Members of that program earn points, which they can redeem for tangible rewards such as concession-stand items and movie tickets. This program, named Scene, has been a hit, having reached 90 percent of its membership target in its first six months. In just one year, more than 600,000 people joined the program.

Perishability is another big issue for Cineplex. A theatre that is only half full on weeknights means permanently lost revenue. Cineplex addresses this problem through alternative program offerings that bring in new audiences, smooth out demand, and boost revenues. Instead of movies, Cineplex has broadcast live concerts by popular artists, as well as opera performances on a pay-per-view basis. It also offers various sporting events (professional wrestling, World Cup soccer, NHL games), which customers can see at a fraction of the cost of seeing them live. These offerings have helped neutralize perishability effects. More important, these add-on events to movies have allowed Cineplex to reach audiences—demographically speaking—that seldom if ever go to the movies.

Courtesy of Magic Marketing, www.magicmarketing.ca

OBJECTIVE 2

Discuss the interrelationship of cost accumulation, cost measurement, and cost assignment.

Setting Up the Cost Accounting System

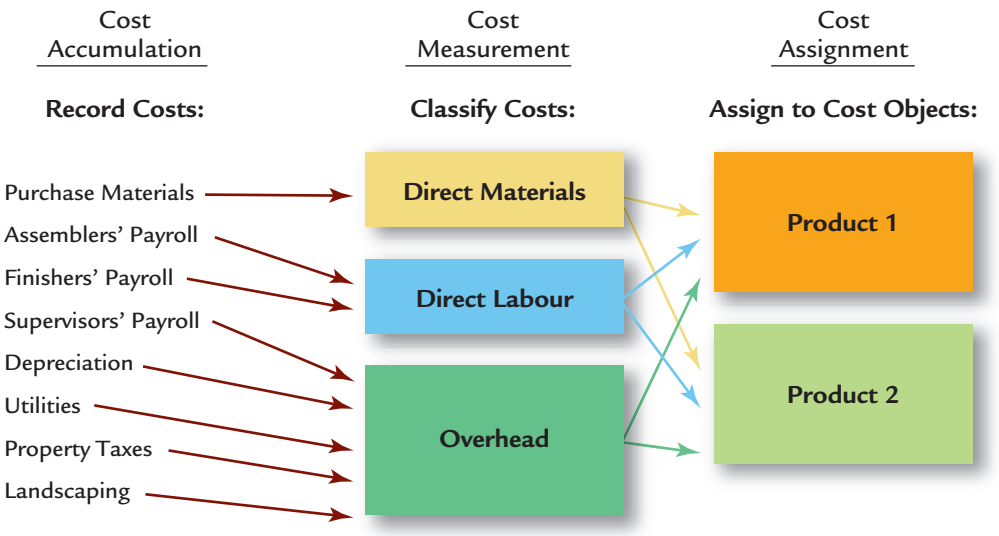
Once the characteristics of a firm's production process are understood, the accountant can set up a system for generating appropriate cost information. A good cost accounting information system is flexible and reliable. It provides information for a variety of purposes and can be used to answer different types of questions. In general, the system is used to satisfy the needs for cost accumulation, cost measurement, and cost assignment. **Cost accumulation** is the recognition and recording of costs. **Cost measurement** involves determining the dollar amounts of direct materials, direct labour, and overhead used in production. **Cost assignment** is the association of production costs with the units produced. Exhibit 4-3 illustrates the relationship of cost accumulation, cost measurement, and cost assignment.

Cost Accumulation

Cost accumulation refers to the recognition and recording of costs. The cost accountant needs to develop source documents that keep track of costs as they occur. A **source document** describes a transaction. Data from these source documents can then be recorded in a database. The recording of data in a database allows

Exhibit 4-3

Relationship of Cost Accumulation, Cost Measurement, and Cost Assignment



accountants and managers the flexibility to analyze subsets of the data as needed to aid in management decision making. The cost accountant can also use the database to see that the relevant costs are recorded in the general ledger and posted to appropriate accounts for purposes of external financial reporting.

Well-designed source documents can supply information in a flexible way. In other words, the information can be used for multiple purposes. For example, the sales receipt written up or input by a clerk when a customer buys merchandise lists the date, the items purchased, the quantities, the prices, the sales tax paid, and the total dollar amount received. Just this one source document can be used in determining sales revenue for the month, the sales by each product, the tax owed to the government, and the cash received or the accounts receivable recorded. Similarly, employees often fill in labour time tickets, indicating which jobs they worked on, on what date, and for how long. Data from the labour time ticket can be used in determining direct labour cost used in production, the amount to pay the worker, the degree of productivity improvement achieved over time, and the amount to budget for direct labour for an upcoming job.

Cost Measurement

Once costs are accumulated (recorded), they can be classified or organized in a meaningful way. Cost measurement refers to classifying the costs. For example, in manufacturing it may consist of determining the dollar amounts of direct materials, direct labour, and overhead used in production. The dollar amounts may be the actual amounts expended for the manufacturing inputs or they may be estimated amounts. Often, bills for overhead items arrive after the unit cost must be calculated; therefore, estimated amounts are used to ensure timeliness of cost information and to control costs.

There are two commonly used ways to *measure* the costs associated with production: *actual costing* and *normal costing*. Actual costing requires the firm to use the actual cost of all resources used in production to determine unit cost. The second method, normal costing, requires the firm to apply actual costs of direct materials and direct labour to units produced. However, overhead is applied based on a predetermined estimate. Normal costing is more widely used in practice.

Actual versus Normal Costing

An **actual cost system** uses actual costs for direct materials, direct labour, and overhead to determine unit cost. In practice, strict actual cost systems are rarely used because they cannot provide accurate unit cost

information on a timely basis. Per-unit computation of the direct materials and direct labour costs is not the problem. Direct materials and direct labour can be traced to units produced. The main problem with using actual costs for calculation of unit cost is with manufacturing overhead. There are three reasons why this is so.

First, a traditional system applies overhead using unit-based drivers. However, many overhead items cannot be traced to units of production. Depreciation on plant and equipment, purchasing, and receiving are costs that are not associated with unit-based drivers. Activity-based costing is a way of overcoming this difficulty by using multiple drivers—both unit- and non-unit-based.

Second, many overhead costs are not incurred uniformly throughout the year; they can change significantly from one month to the next. For example, a factory located in northern Alberta may incur higher utilities costs in the winter as it heats the factory. Even if the factory always produces 10,000 units a month, the per-unit overhead cost in December will be higher than the per-unit overhead cost in June. As a result, one unit of product costs more in one month than another, even though the units are identical, and the production process is the same. The difference in the per-unit overhead cost is due to actual overhead costs that were incurred nonuniformly.

The third reason is that per-unit overhead costs fluctuate dramatically because of nonuniform production levels. Suppose a factory has seasonal production; it may produce 10,000 units in March, but 30,000 units in September as it gears up for the Christmas buying season. Then, if all other costs remain the same, month to month, the per-unit overhead of the product will be approximately three times as high in March as in September. Again, the units are identical, and the production process is the same.

The problem of fluctuating per-unit overhead costs can be avoided if the firm waits until the end of the year to assign the overhead costs. Unfortunately, waiting until the end of the year to determine overhead costs per unit is unacceptable. A company needs timely unit cost information throughout the year, both for interim financial statements and to help managers make decisions such as pricing. Most decisions requiring unit cost information simply cannot wait until the end of the year. Managers must react to day-to-day conditions in the marketplace in order to maintain a sound competitive position.

Normal costing solves the problems associated with actual costing. A cost system that measures overhead costs on a predetermined basis and uses actual costs for direct materials and direct labour is called a **normal costing system**. Predetermined overhead or activity rates are calculated at the beginning of the year and are used to apply overhead to production as the year goes on. Any difference between actual and applied overhead is handled as an overhead variance (overapplied–underapplied overhead).

Virtually all firms assign overhead to production on a predetermined basis. This fact seems to suggest that most firms successfully approximate the end-of-the-year overhead rate. Thus, the measurement problems associated with the use of actual overhead costs are solved by the use of estimated overhead costs. A job-order costing system that uses actual costs for direct materials and direct labour and estimated costs for overhead is called a *normal job-order costing system*.

Cost Assignment

Once costs have been accumulated and measured, they are assigned to units of product manufactured or units of service delivered. Unit costs are important for a wide variety of purposes. For example, bidding is a common requirement in markets for custom homes and industrial buildings. It is virtually impossible to submit a meaningful bid without knowing the costs associated with the units to be produced. Product cost information is vital in a number of other areas as well. Decisions concerning product design and introduction of new products are affected by expected unit costs. Decisions to make or buy a product, to accept or reject a special order, or to keep or drop a product line require unit cost information.

In its simplest form, computing the unit manufacturing or service cost is easy. The unit cost is the total product cost associated with the units produced divided by the number of units produced. For example, if a toy company manufactures 100,000 tricycles and the total cost of direct materials, direct labour, and overhead for these tricycles is $1,500,000, then the cost per tricycle is $15 ($1,500,000/100,000). Although the concept is simple, the practical reality of the computation is more complex and breaks down when there are products that differ from one another or when the company needs to know the cost of the product before all of the actual costs associated with its production are known.

Importance of Unit Costs to Manufacturing Firms Unit cost is a critical piece of information for a manufacturer. Unit costs are essential for valuing inventory, determining income, and making a number of important decisions.

Disclosing the cost of inventories and determining income are financial reporting requirements that a firm faces at the end of each period. In order to report the cost of its inventories, a firm must know the number of units on hand and the unit cost. The cost of goods sold, used to determine income, also requires knowledge of the units sold and their unit cost.

Whether or not the unit cost information should include all manufacturing costs depends on the purpose for which the information is going to be used. For financial reporting, full or absorption unit cost information is required. If a firm is operating below its production capacity, however, variable cost information may be much more useful in a decision to accept or reject a special order. Thus, unit cost information needed for external reporting may not supply the information necessary for a number of internal decisions, especially those decisions that are short run in nature. Different costs are needed for different purposes.

Full cost information is useful as an input for a number of important internal decisions as well as for financial reporting. In the long run, for any product to be viable, its price must cover its full cost. Decisions to introduce a new product, to continue a current product, and to analyze long-run prices are examples of important internal decisions that rely on full unit cost information.

Importance of Unit Costs to Nonmanufacturing Firms Service and nonprofit firms also require unit cost information. Conceptually, the way companies accumulate and assign costs is the same whether or not the firm is a manufacturing firm. The service firm must first identify the service "unit" being provided. In an auto repair shop, the service unit would be the work performed on an individual customer's car. Because each car is different in terms of the work required (an oil change versus a transmission overhaul, for example), the costs must be assigned individually to each job. A hospital would accumulate costs by patient, patient day, and type of procedure (e.g., X-ray, complete blood count test). A governmental agency must also identify the service provided. For example, city government might provide household trash collection and calculate the cost by truck run or by collection per house.

Service firms use cost data in much the same way that manufacturing firms do. They use costs to determine profitability, the feasibility of introducing new services, and so on. However, because service firms do not produce physical products, they do not need to value work-in-process and finished goods inventories. Of course, they may have supplies, and the inventory of supplies is simply valued at historical cost.

Nonprofit firms must track costs to be sure that they provide their services in a cost-efficient way. Governmental agencies have a fiduciary responsibility to taxpayers to use funds wisely. This requires accurate accounting for costs.

Direct materials and direct labour costs are traced to units of production. There is a clear relationship between the amount of materials and labour used and the level of production. Actual costs can be used because the actual cost of materials and labour are known reasonably well at any point in time.

Overhead is applied using a predetermined rate based on budgeted overhead costs and budgeted amount of driver. Two considerations arise. One is the choice of

the activity base or driver. The other is the choice of activity base or driver for plant-wide, departmental, and activity-based overhead rates.

Choosing the Activity Level

Once the measure(s) of activity are chosen, we still need to predict the level of activity usage that applies to the coming year. Although any reasonable level of activity could be chosen, the two leading candidates are expected actual activity and normal activity. **Expected activity level** is simply the production level the firm expects to attain for the coming year. **Normal activity level** is the average activity usage that a firm experiences in the long term (normal volume is computed over more than one year).

For example, assume that Paulos Manufacturing expects to produce 18,000 units next year and has budgeted overhead for the year at $216,000. Over the past four years, Paulos Manufacturing produced the following number of units:

Year 1	22,000
Year 2	17,000
Year 3	21,000
Year 4	20,000

If expected actual capacity is used, Paulos Manufacturing will apply overhead using a predetermined rate of $12 ($216,000/18,000). However, if normal capacity is used, then the denominator of the equation for predetermined overhead is the average of the past four years of activity, or 20,000 units [(22,000 + 17,000 + 21,000 + 20,000)/4]. Then the predetermined overhead rate to be used for the coming year is $10.80 ($216,000/20,000).

Which choice is better? Of the two, normal activity has the advantage of using much the same activity level year after year. As a result, it produces less fluctuation from year to year in the assignment of per-unit overhead cost. Of course, if activity stays fairly stable, then the normal capacity level is roughly equal to the expected actual capacity level.

Other activity levels used for computing **predetermined overhead rates** are those corresponding to the theoretical and practical levels. **Theoretical activity level** is the absolute maximum production activity of a manufacturing firm. It is the output that can be realized if everything operates perfectly. **Practical activity level** is the maximum output that can be realized if everything operates efficiently. Efficient operation allows for some imperfections such as normal equipment breakdowns, some shortages, and workers operating at less than peak capability. Normal and expected actual activities tend to reflect consumer demand, while theoretical and practical activities reflect a firm's production capabilities.

OBJECTIVE 3
Identify the source documents used in job-order costing.

The Job-Order Costing Overview

As we have seen, manufacturing and service firms can be divided into two major industrial types based on the uniqueness of their product. The degree of product or service heterogeneity affects how we track costs. As a result, three different cost assignment systems have been developed: job-order costing, operation costing, and process costing.

Firms operating in job-order industries produce a wide variety of products or jobs that are usually quite distinct from one another. Customized or built-to-order products fit into this category, as do services that vary from customer to customer. Examples of job-order processes include printing, construction, furniture making, automobile repair, and beautician services. In manufacturing, a job may be a single unit such as a house, or it may be a batch of units such as eight tables. Job-order systems may be used to produce goods for inventory that are subsequently sold in the general market. Often, however, a job is associated with a particular customer order.

The key feature of job-order costing is that the cost of one job differs from that of another job and must be monitored separately.

For job-order production systems, costs are accumulated by *job*. This approach to assigning costs is called a **job-order costing system**. In a job-order firm, collecting costs by job provides vital information for management. Once a job is completed, the unit cost can be obtained by dividing the total manufacturing costs by the number of units produced. For example, if the production costs for printing 100 wedding announcements total $350, then the unit cost for this job is $3.50. The manager of the printing firm can compare the unit cost information with the prevailing market price to see if there is a reasonable profit margin. If there is not, then this may signal that the costs are out of line with other printing firms, and the manager may work to reduce costs, or alternatively, seek to emphasize other types of jobs for which the firm can earn a reasonable profit margin. In fact, the profit contributions of different printing jobs offered by the firm can be computed, and this information can then be used to select the most profitable mix of printing services to offer.

In illustrating job-order costing, we will assume a normal costing measurement approach. The actual costs of direct materials and direct labour are assigned to jobs along with overhead applied using a predetermined overhead rate. *How* these costs are actually assigned to the various jobs, however, is the central issue. In order to assign these costs, we must identify each job and the direct materials and direct labour associated with it. Additionally, some mechanism must exist to allocate overhead costs to each job.

The document that identifies each job and accumulates its manufacturing costs is the **job-order cost sheet**. An example is shown in Exhibit 4-4. The cost accounting department creates such a cost sheet upon receipt of a production order. Orders are written up in response to a specific customer order or in conjunction with a

Exhibit 4-4

The Job-Order Cost Sheet

Job Number 16

For Benson Company — Date Ordered April 2, 2013

Item Description Valves — Date Completed April 24, 2013

Quantity Completed 100 — Date Shipped April 25, 2013

Direct Materials		Direct Labour				Overhead		
Requisition Number	Amount	Ticket Number	Hours	Rate	Amount	Hours	Rate	Amount
12	$300	68	8	$6	$ 48	8	$10	$ 80
18	450	72	10	7	70	10	10	100
	$750				$118			$180

Cost Summary

Direct materials	$ 750
Direct labour	118
Overhead	180
Total cost	$1,048
Unit cost	$10.48

production plan derived from a sales forecast. Each job-order cost sheet has a job-order number that identifies the new job. In a small company, with relatively few jobs, the name of the customer may be used to identify the job. For example, a housing contractor may identify jobs as "Oltman's house" or "Rhea's house." A firm with many jobs may set up a system in which the first four numbers are the year, and the succeeding numbers identify the job in that year. Jobs in this example might be labelled "2013-001" or "2013-089." The key point is that each job is unique and that its costs must be recorded separately from the costs of other jobs. Every job in process at any point in time should have a job-order cost sheet in which all costs associated with the job are entered.

In a manual accounting system, the job-order cost sheet is a document. Today, however, most accounting systems are automated. The cost sheet usually corresponds to a record in a work-in-process inventory master file. The collection of all job cost sheets defines a **work-in-process inventory file**. In a manual system, the file is located in a filing cabinet, whereas in an automated system, it is stored electronically. In either system, the file of job-order cost sheets serves as a subsidiary work-in-process inventory ledger.

Both manual and automated systems require the same kind of data in order to accumulate costs and track the progress of a job. A job-order costing system must be able to identify the quantity of direct materials, direct labour, and overhead used by each job. Documentation and procedures are needed to associate the resources used by a job with the job itself. This need is satisfied through the use of materials requisitions for direct materials, time tickets for direct labour, and predetermined rates for overhead.

Materials Requisitions

The cost of direct materials is assigned to a job by the use of a source document known as a **materials requisition form**, illustrated in Exhibit 4-5. Notice that the form asks for the description, quantity, and unit cost of the direct materials issued and, most importantly, for the job number. Using this form, the Cost Accounting

Exhibit 4-5

Materials Requisition Form

Materials Requisition
Number 678

Date April 8, 2013

Department Grinding

Job Number 62

Description	Quantity	Cost/Unit	Total Cost
Casing	100	$3	$300

Authorized Signature Jim Lawson

Department can enter the total cost of direct materials right onto the and job-order cost sheet. If the accounting system is automated, the data are entered directly at a computer terminal, using the materials requisition forms as source documents. A program then enters the cost of direct materials onto the record for each job.

In addition to providing essential information for assigning direct materials costs to jobs, the materials requisition form may also have other data items such as requisition number, date, and signature. These items are used to maintain proper control over a firm's inventory of direct materials. The signature, for example, transfers responsibility for the materials from the storage area to the person receiving the materials, usually a production supervisor.

No attempt is made to trace the cost of other materials, such as supplies, lubricants, and so on, to a particular job. These indirect materials are part of overhead and are assigned to jobs through the predetermined overhead rate.

Job Time Tickets

Direct labour must be assigned to each particular job. This is done using a source document known as a **time ticket** (see Exhibit 4-6). When an employee works on a particular job, she fills out a time ticket that identifies her name, wage rate, hours worked, and job number. These time tickets are collected daily and transferred to the Cost Accounting Department, where the information is used to post the cost of direct labour to individual jobs. Again, in an automated system, posting involves entering the data onto the computer.

Time tickets are used only for direct labourers. Since indirect labour is common to all jobs, these costs belong to overhead and are allocated using the predetermined overhead rate.

Overhead Application

Jobs are assigned overhead costs with the predetermined overhead rate. Typically, direct labour hours is the measure used to calculate overhead. For example, assume that a firm has estimated overhead costs for the coming year of $900,000 and that expected activity is 90,000 direct labour hours. The predetermined overhead rate is $900,000/90,000 direct labour hours = $10 per direct labour hour.

Exhibit 4-6

Time Ticket

Time Ticket Number 68

Employee Number 45

Name Ann Wilson

Date April 12, 2013

Start Time	Stop Time	Total Time	Hourly Rate	Amount	Job Number
8:00	10:00	2	$10	$20	16
10:00	11:00	1	10	10	17
11:00	12:00	1	10	10	16
1:00	6:00	5	10	50	16

Approved by Jim Lawson
Department Supervisor

Since the number of direct labour hours charged to a job is known from time tickets, the assignment of overhead costs to jobs is simple once the predetermined rate has been computed. For instance, Exhibit 4-6 reveals that Ann Wilson worked a total of eight hours on Job 16. From this time ticket, overhead totalling $80 ($10 × 8 hours) would be assigned to Job 16.

What if overhead is assigned to jobs based on something other than direct labour hours? Then the other driver must be accounted for as well. That is, the actual amount used of the other driver (e.g., machine hours) must be collected and posted to the job cost sheets. Employees must create a source document that will track the machine hours used by each job. A machine time ticket could easily accommodate this need.

Unit Cost Calculation

Once a job is completed, its total manufacturing cost is computed by first totalling the costs of direct materials, direct labour, and overhead, and then summing these individual totals. If there are multiple units in a job, the grand total can be divided by the number of units produced to obtain the unit cost. Cornerstone 4-1 shows how and why to set up a simplified job-order cost sheet. Notice that the simplified sheet illustrated in Cornerstone 4-1 leaves out the detail of the job-order cost sheet illustrated in Exhibit 4-4. This simplified sheet will be useful in organizing the information for homework problems and test problems.

All completed job-order cost sheets of a firm can serve as a subsidiary ledger for the finished goods inventory. In a manual accounting system, the completed sheets would be transferred from the work-in-process inventory files to the finished goods inventory file. In an automated accounting system, an updating run would delete the finished job from the work-in-process inventory master file and add this record to the finished goods inventory master file. In either case, adding the totals of all completed job-order cost sheets gives the cost of finished goods inventory at any point in time.

As finished goods are sold and shipped, the cost records are pulled (or deleted) from the finished goods inventory file. These records then form the basis for calculating a period's cost of goods sold.

OBJECTIVE 4

Describe the cost flows associated with job-order costing, and prepare the journal entries.

Job-Order Costing: Specific Description

Recall that cost flow follows costs from the point at which they are incurred to the point at which they are recognized as expenses on the income statement. Of principal interest in a job-order costing system is the flow of manufacturing costs. Accordingly, we begin with a description of exactly how we account for the three manufacturing cost elements (direct materials, direct labour, and overhead).

A simplified job shop environment is used as the framework for this description. All Signs Company, recently formed by Bob Fredericks, produces a wide variety of customized signs. Bob has leased a small building and bought the necessary production equipment. For the first month of operation (January), Bob has finalized two orders: one for 20 street signs for a new housing development, and a second for 10 laser-carved wooden signs for a golf course. Both orders must be delivered by January 31 and will be sold for manufacturing cost plus 50 percent. Bob expects to average two orders per month for the first year of operation.

Bob has created two job-order cost sheets and assigned a number to each job. Job 101 is the street signs, and Job 102 is the golf course signs.

Accounting for Direct Materials

Since the company is beginning its business, it has no beginning inventories. To produce the 30 signs in January and retain a supply of direct materials on hand at the

The HOW and WHY of Setting Up a Simplified Job-Order Cost Sheet

CORNERSTONE 4-1

Information:

All-Round Fence Company installs fences for homeowners and small commercial firms. During March, All-Round worked on three jobs. Data relating to these three jobs follow:

	Job 62	Job 63	Job 64
Beginning balance	$ 620	$ 0	$ 0
Materials requisitioned	4,900	4,600	3,000
Direct labour cost	2,500	1,740	1,600

Overhead is assigned at the rate of 60 percent of direct labour cost. During March, Job 62 was completed and sold at 125 percent of cost. Jobs 63 and 64 remain unfinished at the end of the month.

Why:

Because each job is unique in terms of the cost of materials and labour, costs must be tracked separately by job.

Required:

1. What is the meaning of the beginning balance for Job 62? Why is there no beginning balance for Jobs 63 and 64?
2. Set up a simple job-order cost sheet for Jobs 62, 63, and 64.
3. Calculate the price and the gross margin for Job 62.
4. ***What if*** the overhead rate was 80 percent of direct labour cost? How would the costs added to the three jobs be affected?

Solution:

1. Because Job 62 had a beginning balance on March 1, it must have been started earlier (in February, say) and some costs must have already been incurred. The job was clearly not finished since more cost was added in March.

2.

	Job 62	Job 63	Job 64
Beginning balance	$ 620	$ 0	$ 0
Materials requisitioned	4,900	4,600	3,000
Direct labour cost	2,500	1,740	1,600
Applied overhead*	1,500	1,044	960
Total cost	$9,520	$7,384	$5,560

*Applied overhead is 0.6 × Direct labour cost.

3. Job 62 price = $9,520 + (0.25 × $9,520) = $11,900
   Job 62 gross margin = $11,900 − $9,520 = $2,380

4. If the overhead rate was 80 percent of direct labour cost, rather than 60 percent, the applied overhead for each job would be higher and the total cost would be higher. Since cost is used as the basis of price, the bid prices would also be higher.

beginning of February, Bob purchases, on account, $2,500 of direct materials. This purchase is recorded as follows:

1.	Materials Inventory	2,500	
	Accounts Payable		2,500

Materials Inventory is an inventory account. It also is the controlling account for all raw materials. When materials are purchased, the cost of these materials "flows" into the materials inventory account.

From January 2 to January 19, the production supervisor used three requisition forms to remove $1,000 of direct materials from the storeroom. From January 20 to January 31, two additional requisition forms for $500 of direct materials were used. The first three forms revealed that the direct materials were used for Job 101; the last two requisitions were for Job 102. Thus, for January, the cost sheet for Job 101 would have a total of $1,000 in direct materials posted, and the cost sheet for Job 102 would have a total of $500 in direct materials posted. In addition, the following entry would be made:

2.	Work-in-Process Inventory	1,500	
	Materials Inventory		1,500

This second entry captures the flow of direct materials flowing from the storeroom to work in process. All such flows are summarized in the work-in-process inventory account and are posted individually to the respective jobs. Work-in-Process Inventory is a controlling account, and the job cost sheets are the subsidiary accounts. Exhibit 4-7 summarizes the direct materials cost flows. Notice that the source document that drives the direct materials cost flows is the materials requisition form.

Accounting for Direct Labour Cost

Since two jobs were in progress during January, time tickets filled out by direct labourers must be sorted by each job. Once the sorting is completed, the hours worked and the wage rate of each employee are used to assign the direct labour cost to each job. For Job 101, the time tickets showed 60 hours at an average wage rate of $10 per hour, for a total direct labour cost of $600. For Job 102, the total was $250, based on 25 hours at an average hourly wage of $10. In addition to the postings to each job's cost sheet, the following summary entry would be made:

3.	Work-in-Process Inventory	850	
	Wages Payable		850

Exhibit 4-7

Summary of Direct Materials Cost Flows

Subsidiary Accounts (Cost Sheets)

Job 101
Direct Materials

Req. No.	Amount
1	$ 300
2	200
3	500
	$1,000

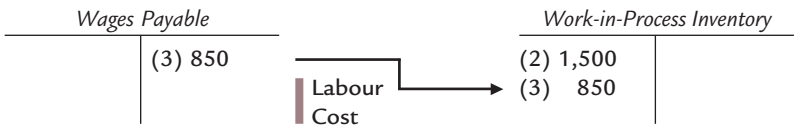
Job 102
Direct Materials

Req. No.	Amount
4	$250
5	250
	$500

Source Documents: Materials Requisitions Forms

Exhibit 4-8

Summary of Direct Labour Cost Flows



Work-in-Process Inventory Subsidiary Accounts (Cost Sheets)

Job 101
Labour

Ticket	Hours	Rate	Amount
1	15	$10	$150
2	20	10	200
3	25	10	250
	60		$600

Job 102
Labour

Ticket	Hours	Rate	Amount
4	15	$10	$150
5	10	10	100
	25		$250

Source Documents: Time Tickets

The summary of the direct labour cost flows is given in Exhibit 4-8. Notice that the direct labour costs assigned to the two jobs exactly equal the total assigned to Work-in-Process Inventory. Note also that the time tickets filled out by the individual labourers are the source of information for posting the labour cost flows. Remember that the labour cost flows reflect only direct labour cost. Indirect labour is assigned as part of overhead.

Accounting for Overhead

Under a normal costing approach, actual overhead costs are *never* assigned to jobs. Overhead is applied to each individual job using a predetermined overhead rate. Recall, however, that a company must still account for *actual overhead costs* incurred. We will first describe how to account for applied overhead and then discuss accounting for actual overhead.

Accounting for Overhead Application Assume that Bob has estimated overhead costs for the year at $9,600. Additionally, since he expects business to increase throughout the year as he becomes established, he estimates 2,400 total direct labour hours. Accordingly, the predetermined overhead rate is as follows:

$$\text{Overhead rate} = \$9{,}600/2{,}400 = \$4 \text{ per direct labour hour}$$

Overhead costs flow into Work-in-Process Inventory via the predetermined rate. Since direct labour hours are used to assign overhead into production, the time tickets serve as the source documents for assigning overhead to individual jobs and to the controlling work-in-process inventory account.

For Job 101, with a total of 60 hours worked, the amount of overhead cost posted is $240 ($4 × 60). For Job 102, the overhead cost is $100 ($4 × 25). A summary entry reflects a total of $340 (i.e., all overhead applied to jobs worked on during January) in applied overhead.

4.	Work-in-Process Inventory	340	
	Overhead Control		340

The credit balance in the overhead control account equals the total applied overhead at a given point in time. In normal costing, only applied overhead ever enters the work-in-process inventory account.

Accounting for Actual Overhead Costs To illustrate how actual overhead costs are recorded, assume that All Signs Company incurred the following indirect costs for January:

Lease payment	$200
Utilities	50
Equipment depreciation	100
Indirect labour	65
Total overhead costs	$415

As indicated earlier, actual overhead costs never enter the work-in-process inventory account. The usual procedure is to record actual overhead costs on the debit side of the overhead control account. For example, the actual overhead costs would be recorded as follows:

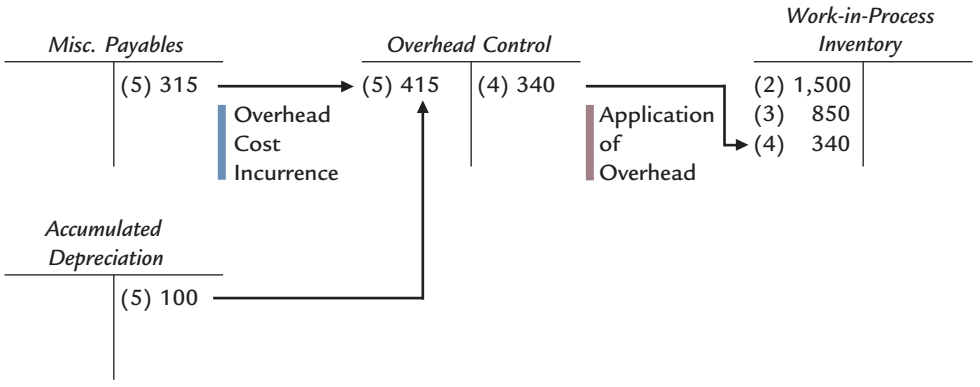
5.	Overhead Control	415	
	Lease Payable		200
	Utilities Payable		50
	Accumulated Depreciation—Equipment		100
	Wages Payable		65

Thus, the debit balance in Overhead Control gives the total actual overhead costs at a given point in time. Since actual overhead costs are on the debit side of this account and applied overhead costs are on the credit side, the balance in Overhead Control is the overhead variance at a given point in time. For All Signs Company at the end of January, the actual overhead of $415 and applied overhead of $340 produce underapplied overhead of $75 ($415 – $340).

The flow of overhead costs is summarized in Exhibit 4-9. To apply overhead to work-in-process inventory, a company needs information from the time tickets and a predetermined overhead rate based on direct labour hours.

Exhibit 4-9

Summary of Overhead Cost Flows



Work-in-Process Inventory Subsidiary Accounts (Cost Sheets)

Job 101
Applied Overhead

Hours	Rate	Amount
60	$4	$240

Job 102
Applied Overhead

Hours	Rate	Amount
25	$4	$100

Source Documents: Time Ticket
Other Source: Predetermined Rate

Accounting for Finished Goods Inventory

We have already seen what takes place when a job is completed. The columns for direct materials, direct labour, and applied overhead are totalled. These totals are then transferred to another section of the cost sheet, where they are summed to yield the manufacturing cost of the job. This job cost sheet is then transferred to a finished goods inventory file. Simultaneously, the costs of the completed job are transferred from the work-in-process inventory account to the finished goods inventory account.

For example, assume that Job 101 was completed in January with the completed job-order cost sheet shown in Exhibit 4-10. Since Job 101 is completed, the total manufacturing costs of $1,840 must be transferred from the work-in-process inventory account to the finished goods inventory account. This transfer is described by the following entry:

6.	Finished Goods Inventory	1,840	
	Work-in-Process Inventory		1,840

Exhibit 4-11 shows a summary of the cost flows that occur when a job is finished.

Completion of goods in a manufacturing process represents an important step in the flow of manufacturing costs. Because of the importance of this stage in a manufacturing operation, a schedule of the cost of goods manufactured is prepared periodically to summarize the cost flows of all production activity. This report is an important input for a firm's income statement and can be used to evaluate a firm's manufacturing effort. The statement of cost of goods manufactured was first introduced in Chapter 1. However, in a normal costing system, the report is somewhat different from the actual cost report presented in that chapter.

Exhibit 4-10

Completed Job-Order Cost Sheet

Job Number 101

For Housing Development — Date Ordered Jan. 1, 2013

Item Description Street Signs — Date Started Jan. 2, 2013

Quantity Completed 20 — Date Finished Jan. 15, 2013

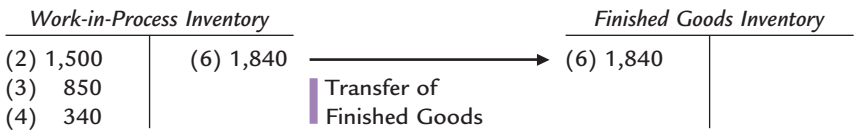
Direct Materials		Direct Labour				Applied Overhead		
Requisition Number	Amount	Ticket Number	Hours	Rate	Amount	Hours	Rate	Amount
1	$ 300	1	15	$10	$150	15	$4	$ 60
2	200	2	20	10	200	20	4	80
3	500	3	25	10	250	25	4	100
	$1,000				$600			$240

Cost Summary

Direct materials	$1,000
Direct labour	600
Overhead	240
Total cost	$1,840
Unit cost	$92

Exhibit 4-11

Summary of Finished Goods Cost Flow



The statement of cost of goods manufactured presented in Exhibit 4-12 summarizes the production activity of All Signs Company for January. The key difference between this report and the one appearing in Chapter 1 is the use of applied overhead to arrive at the cost of goods manufactured. Finished goods inventories are carried at *normal cost* rather than the *actual cost*.

Notice that ending work-in-process inventory is $850. Where did we obtain this figure? Of the two jobs, Job 101 was finished and transferred to Finished Goods Inventory at a cost of $1,840. This amount is credited to Work-in-Process Inventory, leaving an ending balance of $850. Alternatively, we can add up the amounts debited to Work-in-Process Inventory for all remaining unfinished jobs. Job 102 is the only job still in process. The manufacturing costs assigned thus far are direct materials, $500; direct labour, $250; and overhead applied, $100. The total of these costs gives the cost of ending work-in-process inventory.

Accounting for Cost of Goods Sold

In a job-order firm, units can be produced for a particular customer or they can be produced with the expectation of selling the units as market conditions warrant.

Exhibit 4-12

Statement of Cost of Goods Manufactured

All Signs Company
Statement of Cost of Goods Manufactured
For the Month Ended January 31, 2013

Direct materials		
Beginning direct materials inventory	$ 0	
Add: Purchases of direct materials	2,500	
Total direct materials available	2,500	
Less: Ending direct materials	1,000	
Direct materials used		$1,500
Direct labour		850
Manufacturing overhead		
Lease	200	
Utilities	50	
Depreciation	100	
Indirect labour	65	
	415	
Less: Underapplied overhead	75	
Overhead applied		340
Current manufacturing costs		2,690
Add: Beginning work-in-process inventory		0
Less: Ending work-in-process inventory		(850)
Cost of goods manufactured		$1,840

When the job is shipped to the customer, the cost of the finished job becomes the cost of the goods sold. When Job 101 is shipped, the following entries will made. (Recall that the selling price is 150 percent of manufacturing cost.)

7a.	Cost of Goods Sold	1,840	
	Finished Goods Inventory		1,840
7b.	Accounts Receivable	2,760	
	Sales Revenue		2,760

In addition to these entries, a statement of cost of goods sold usually is prepared at the end of each reporting period (e.g., monthly and quarterly). Exhibit 4-13 presents such a statement for All Signs Company for January. Typically, the overhead variance is not material and is therefore closed to the cost of goods sold account. Cost of goods sold *before* adjustment for an overhead variance is called **normal cost of goods sold**. After adjustment for the period's overhead variance takes place, the result is called the **adjusted cost of goods sold**. It is this latter figure that appears as an expense on the income statement. Cornerstone 4-2 shows how and why the job-order cost sheet can be used in determining the ending balances of Work in Process, Finished Goods, and Cost of Goods Sold.

Closing the overhead variance to the cost of goods sold account is done once, at the end of the year. Variances are expected each month because of nonuniform production and nonuniform actual overhead costs. As the year unfolds, these monthly variances should, by and large, offset one another so that the year-end variance is small. Nonetheless, to illustrate how the year-end overhead variance would be treated, we will close out the overhead variance experienced by All Signs Company in January.

Closing the underapplied overhead to cost of goods sold requires the following entry:

8.	Cost of Goods Sold	75	
	Overhead Control		75

Notice that debiting Cost of Goods Sold is equivalent to adding the underapplied amount to the normal cost of goods sold figure. If the overhead variance is overapplied, then the entry will reverse, and Cost of Goods Sold will be credited.

If Job 101 had not been ordered by a customer but had been produced with the expectation that the signs could be sold to various other developers, then all 20 units may not be sold at the same time. Assume that on January 31, 15 signs were sold. In this case, the cost of goods sold figure is the unit cost times the number of units sold ($92 × 15, or $1,380).

Exhibit 4-13

Statement of Cost of Goods Sold

All Signs Company
Statement of Cost of Goods Sold
For the Month Ended January 31, 2013

Beginning finished goods inventory	$ 0
Cost of goods manufactured	1,840
Goods available for sale	1,840
Less: Ending finished goods inventory	0
Normal cost of goods sold	1,840
Add: Underapplied overhead	75
Adjusted cost of goods sold	$1,915

CORNERSTONE 4-2

The HOW and WHY of Using a Job-Order Cost Sheet to Determine the Balances of Work in Process, Finished Goods, and Cost of Goods Sold

Information:

(We use the same data as Cornerstone 4-1.) All-Round Fence Company installs fences for homeowners and small commercial firms. During March, All-Round worked on three jobs. Completed job-order cost sheets for March (from Cornerstone 4-1) follow:

	Job 62	Job 63	Job 64
Beginning balance	$ 620	$ 0	$ 0
Materials requisitioned	4,900	4,600	3,000
Direct labour cost	2,500	1,740	1,600
Applied overhead	1,500	1,044	960
Total cost	$9,520	$7,384	$5,560

During March, Job 62 was completed and sold at 125 percent of cost. Jobs 63 and 64 remain unfinished at the end of the month.

Why:

Since all costs are tracked by job, the balance in Work in Process can be computed by summing the costs of all completed jobs. The amount added to Finished Goods is the sum of jobs completed but not sold. Cost of Goods Sold must be the total cost of all jobs sold during the month.

Required:

1. What is the ending balance of Work in Process for March?
2. Assume that the March 1 balance of Finished Goods was zero. What is the ending balance of Finished Goods for March?
3. What is the cost of goods sold for March?
4. ***What if*** the March 1 balance of Finished Goods was $4,560 (consisting of Job 61)? What is the ending balance of Finished Goods in March?

Solution:

1. Since Jobs 63 and 64 are unfinished by March 31, their total cost must be the balance in Work in Process.

   March 31 Work in Process = $7,384 + $5,560 = $12,944

2. Since no jobs were completed but not sold, nothing is added to Finished Goods at the end of March. Since the beginning balance in Finished Goods was zero, then the ending balance must also be zero.
3. Cost of goods sold = Job 62 = $9,520
4. If the beginning balance of Finished Goods was $4,560, any newly completed jobs were sold by the end of March, and Job 61 was not sold during March, the ending balance would remain at $4,560.

Closing out the overhead variance to Cost of Goods Sold completes the description of manufacturing cost flows. To facilitate a review of these important concepts, Exhibit 4-14 shows a complete summary of the manufacturing cost flows for All Signs Company. Notice that these entries summarize information from the underlying job-order cost sheets. Although the description in this exhibit is specific to the

Exhibit 4-14

All Signs Company Summary of Manufacturing Cost Flows

Materials Inventory			
(1)	2,500	(2)	1,500

Wages Payable			
		(3)	850

Overhead Control			
(5)	415	(4)	340
		(8)	75

Work-in-Process Inventory			
(2)	1,500	(6)	1,840
(3)	850		
(4)	340		

Finished Goods Inventory			
(6)	1,840	(7a)	1,840

Cost of Goods Sold			
(7a)	1,840		
(8)	75		

(1)	Purchase of direct materials	$2,500
(2)	Issue of direct materials	1,500
(3)	Incurrence of direct labour cost	850
(4)	Application of overhead	340
(5)	Incurrence of actual overhead cost	415
(6)	Transfer of Job 101 to finished goods	1,840
(7a)	Cost of goods sold of Job 101	1,840
(8)	Closing out underapplied overhead	75

example, the pattern of cost flows shown would be found in any manufacturing firm that uses a normal job-order costing system.

Manufacturing cost flows, however, are not the only cost flows experienced by a firm. Nonmanufacturing costs are also incurred. A description of how we account for these costs follows.

Accounting for Nonmanufacturing Costs

Recall that costs associated with selling and general administrative activities are classified as nonmanufacturing costs. These costs are period costs and are never assigned to the product in a traditional costing system. They are not part of the manufacturing cost flows. They do not belong to the overhead category and are treated as a totally separate category.

To illustrate how these costs are accounted for, assume that All Signs Company had the following additional transactions in January:

Advertising circulars	$ 75
Sales commission	125
Office salaries	500
Depreciation, office equipment	50

The following compound entry could be used to record the preceding costs:

Selling Expense Control	200	
Administrative Expense Control	550	
Accounts Payable		75
Wages Payable		625
Accumulated Depreciation—Office Equipment		50

Controlling accounts accumulate all of the selling and administrative expenses for a period. At the end of the period, all of these costs flow to the period's income statement. An income statement for All Signs Company is shown in Exhibit 4-15.

With the description of the accounting procedures for selling and administrative expenses completed, the basic essentials of a normal job-order costing system are also complete. This description has assumed that a single plantwide overhead rate was being used.

Exhibit 4-15

Income Statement

All Signs Company
Income Statement
For the Month Ended January 31, 2013

Sales		$2,760
Less: Cost of goods sold		1,915
Gross margin		845
Less selling and administrative expenses:		
Selling expenses	$200	
Administrative expenses	550	750
Operating income		$ 95

OBJECTIVE 5
Explain how activity-based costing is applied to job-order costing.

Job-Order Costing with Activity-Based Costing

Using a single rate based on direct labour hours to assign overhead may result in inaccurate cost assignments, in that too much or too little overhead is assigned. Departmental overhead rates and activity-based costing are suggested as ways of solving this problem. In job-order costing, departmental overhead rates and activity-based costing affect only the application of overhead. Thus, the job-order costing sheet has additional lines for overhead application, and the source documents must include all drivers for which overhead is applied. Cornerstone 4-3 shows how and why to set up a job-order cost sheet for a company using activity-based costing.

OBJECTIVE 6
Explain how spoiled units are accounted for in a job-order costing system.

Accounting for Spoiled Units in a Traditional Job-Order Costing System

Throughout this chapter, we have assumed that the units produced are good units. However, on occasion, mistakes are made; defective units are produced and are either thrown away or reworked and sold. How do we account for those costs?

Traditional job-order costing makes a distinction between normal and abnormal spoilage. **Normal spoilage** is expected due to the nature of the typical production process. This spoilage may require extra work to make the units saleable, or may result in the units being discarded. For example, from time to time maintenance workers oil the sewing machines in a jeans factory. The next pair of jeans to be sewn may pick up some drops of the machine oil. The jeans are spoiled and discarded. This is normal spoilage and the cost is included in overhead, which is then applied to all units produced. **Abnormal spoilage** is due to the exacting nature of a particular job. This type of spoilage is charged to the job that caused it. Cornerstone 4-4 tells how to treat spoilage and why the distinction between normal and abnormal spoilage is made.

The treatment of spoilage in a job-order environment is to determine whether the spoilage is normal or abnormal and charge the job if it is abnormal. Normal spoilage is considered a cost of doing business. It is subsumed in the overhead rate and spread across all jobs through applied overhead.

The HOW and WHY of Using Activity-Based Costing in Job-Order Costing

CORNERSTONE 4-3

Information:

Chow Company is a job-order costing firm that uses activity-based costing to apply overhead to jobs. Chow identified three overhead activities and related drivers. Budgeted information for the year is as follows:

Activity	Cost	Driver	Amount of Driver
Engineering design	$120,000	Engineering hours	3,000
Purchasing	80,000	Number of parts	10,000
Other overhead	250,000	Direct labour hours	40,000

Chow worked on four jobs in July. Data are as follows:

	Job 60	Job 61	Job 62	Job 63
Balance, July 1	$32,450	$40,770	$29,090	$ 0
Direct materials	$26,000	$37,900	$25,350	$11,000
Direct labour	$40,000	$38,500	$43,000	$20,900
Engineering hours	20	10	15	100
Number of parts	150	180	200	500
Direct labour hours	2,500	2,400	2,600	1,200

By July 31, Jobs 60 and 62 were completed and sold. The remaining jobs were in process.

Why:

ABC requires data to be collected on each activity cost and driver. Then the activity cost is assigned to each job since it is unique in its use of activity drivers.

Required:

1. Calculate the activity rates for each of the three overhead activities.
2. Prepare job-order cost sheets for each job showing all costs through July 31.
3. Calculate the balance in Work in Process on July 31.
4. Calculate cost of goods sold for July.
5. ***What if*** Job 61 required no engineering hours? What is the new cost of Job 61? How would the cost of the other jobs be affected?

Solution:

1. Engineering design rate = $120,000/3,000 = $40 per engineering hour
   Purchasing rate = $80,000/10,000 = $8 per part
   Other overhead = $250,000/40,000 = $6.25 per direct labour hour

2.

	Job 60	Job 61	Job 62	Job 63
Balance, July 1	$ 32,450	$ 40,770	$ 29,090	$ 0
Direct materials	26,000	37,900	25,350	11,000
Direct labour	40,000	38,500	43,000	20,900
Engineering design	800	400	600	4,000
Purchasing	1,200	1,440	1,600	4,000
Other overhead	15,625	15,000	16,250	7,500
Total cost	$116,075	$134,010	$115,890	$47,400

CORNERSTONE 4-3 *(continued)*

3. Work in Process = Job 61 + Job 63 = $134,010 + $47,400 = $181,410
4. Cost of goods sold = Job 60 + Job 62 = $116,075 + $115,890 = $231,965
5. If Job 61 required no engineering time, then the engineering applied to Job 61 would be zero and the cost of Job 61 would decrease by $400. The new Job 61 cost would be $133,610. The cost of the other three jobs would not be affected.

CORNERSTONE 4-4

The HOW and WHY of Accounting for Normal and Abnormal Spoilage in a Job-Order Environment

Information:

Petris Inc. manufactures cabinets on a job-order basis. Job 98-12 calls for 100 units with direct materials of $2,000 and direct labour of $1,000 ($10 per hour times 100 hours). Overhead is applied at the rate of 150 percent of direct labour dollars. At the end of the job, 100 units are produced; however, three of the cabinets required rework due to improper installation of shelving. The rework involved six extra direct labour hours and an additional $50 of material.

Why:

Normal spoilage requires that the additional cost of any rework be charged to Overhead Control. The cost of the job is not assigned any rework cost. If the spoilage is abnormal, any additional cost is assigned to the job requiring the rework.

Required:

1. Assume that the spoilage was due to assigning new, untrained workers to the job and, therefore, is normal spoilage.
   a. Calculate the cost of Job 98-12.
   b. Make any needed journal entry to the overhead control account.
2. Assume that the spoilage is abnormal and is a result of exacting specifications for this job.
   a. Calculate the cost of Job 98-12.
   b. Make any needed journal entry to the overhead control account.
3. ***What if*** three of the cabinets in Job 98-12 were not completely up to specifications due to unevenly applied stain? The stain could not be reworked, but the customer was willing to accept those three for a $20 per cabinet discount in the price. What is the total cost of the job? Would there be any additional entries to Overhead Control?

Solution:

1.

a.

Job 98-12		Overhead Control	
Direct materials	$2,000	Direct materials	$ 50
Direct labour	1,000	Direct labour (6 × $10)	60
Overhead ($1,000 × 150%)	1,500	Overhead ($60 × 150%)	90
Total job cost	$4,500	Total	$200
÷ Units	÷ 100		
Unit cost	$ 45		

CORNERSTONE 4-4 *(continued)*

b. Since the spoilage is normal, none of the rework cost can be charged to the job, and instead must be charged (debited) to Overhead Control.

Overhead Control	110	
Materials		50
Payroll		60

2.

a.

Direct materials ($2,000 + $50)	$2,050
Direct labour [$1,000 + (6 × $10)]	1,060
Overhead ($1,060 × 150%)	1,590
Total job cost	$4,700
÷ Units	÷ 100
Unit cost	$ 47

b. No additional entry is needed to Overhead Control since all costs of the job are added to the job-order cost sheet and flow through Work in Process.

3. If no rework is done, then the job-order cost sheet will look like the one in Requirement 1. Total cost is $4,500, and no additional entries are made to Overhead Control. The price discount will affect the price charged; it will be lower than it otherwise would be.

Summary of Learning Objectives

1. Differentiate the cost accounting systems of service and manufacturing firms and of unique and standardized products.

- Manufacturing firms produce tangible products and need costs for:
  - Inventory measurement on the balance sheet (Materials, Work in Process, Finished Goods)
  - Cost of Goods Sold on the income statement
- Service firms produce intangible products with the following characteristics:
  - Intangibility
  - Inseparability
  - Heterogeneity
  - Perishability
- Uniqueness of units of service or production affect costing method.
  - Job-order costing is used for unique units with unique costs of production.
  - Operation costing is a hybrid of job-order and process costing. Batches consist of unique units.
  - Process costing is used when units are homogeneous.

2. Discuss the interrelationship of cost accumulation, cost measurement, and cost assignment.

- Cost accumulation is the recording of costs in the general ledger.
- Cost measurement refers to the classification and organization of costs.
- Cost assignment determines the cost of particular cost objects (such as units).

3. Identify the source documents used in job-order costing.

- Job-order cost sheets summarize all costs assigned to a job.
  - Subsidiary to work-in-process account
  - Includes direct materials, direct labour, and applied overhead
- Materials requisition forms record materials signed out for use on a job.
- Time tickets are used to keep track of direct labour time used on each job.
- Other source documents track the amount of activity drivers used by each job.

4. Describe the cost flows associated with job-order costing, and prepare the journal entries.

- Costs flow into Work in Process as debits for:
  - Direct materials (credit the materials account)
  - Direct labour (credit the payroll account)
  - Applied overhead (credit the overhead control account)
- Cost of completed jobs is:
  - Debited to Finished Goods (if inventoried) or Cost of Goods Sold (if sold immediately upon completion)
  - Credited to Work in Process
- Cost of Goods Sold is:
  - Debited to Cost of Goods Sold
  - Credited to Finished Goods (if removed from inventory) or Work in Process (if sold immediately upon completion)
- Jobs sold are:
  - Debited to Accounts Receivable or Cash
  - Credited to Sales Revenue

5. Explain how activity-based costing is applied to job-order costing.

- Use of activity drivers must be tracked by job.
- Activity cost is applied to each job by multiplying the activity rate by the job's use of the associated driver.

6. Explain how spoiled units are accounted for in a job-order costing system.

- Normal spoilage is expected.
  - Cost of normal spoilage is included in the overhead rate.
  - All units pick up the cost of normal spoilage.
- Abnormal spoilage is caused by a particular job and is charged directly to that job.

CORNERSTONES FOR CHAPTER 4

CORNERSTONE 4-1 The HOW and WHY of setting up a simplified job-order cost sheet, page 165

CORNERSTONE 4-2 The HOW and WHY of using a job-order cost sheet to determine the balances of work in process, finished goods, and cost of goods sold, page 172

CORNERSTONE 4-3 The HOW and WHY of using activity-based costing in job-order costing, page 175

CORNERSTONE 4-4 The HOW and WHY of accounting for normal and abnormal spoilage in a job-order environment, page 176

Review Problem

Job Cost, Applied Overhead, Unit Cost

Burnaby Company uses a normal job-order costing system. It processes most jobs through two departments. Selected budgeted and actual data for the past year follow. Data for one of several jobs completed during the year also follow.

	Department A	Department B
Budgeted overhead	$100,000	$500,000
Actual overhead	$110,000	$520,000
Expected activity (direct labour hours)	50,000	10,000
Expected machine hours	10,000	50,000

	Job 10
Direct materials	$20,000
Direct labour cost:	
Department A (5,000 hrs @ $6 per hr)	$30,000
Department B (1,000 hrs @ $6 per hr)	$6,000
Machine hours used:	
Department A	100
Department B	1,200
Units produced	10,000

Burnaby Company uses a plantwide, predetermined overhead rate to assign overhead (OH) to jobs. Direct labour hours (DLH) are used to compute the predetermined overhead rate. Burnaby prices its jobs at cost plus 30 percent.

Required:

1. Compute the predetermined overhead rate.
2. Using the predetermined rate, compute the per-unit manufacturing cost for Job 10.
3. Assume that Job 10 was completed in May and sold in September. Prepare journal entries for the completion and sale of Job 10.
4. Recalculate the unit manufacturing cost for Job 10 using departmental overhead rates. Use direct labour hours for Department A and machine hours for Department B. Does this approach provide a more accurate unit cost? Explain.
5. Assume that Job 10 was completed in May and sold in September. Using your work from Requirement 4, prepare journal entries for the completion and sale of Job 10.

Solution:

1. Predetermined overhead rate = $600,000/60,000 = $10 per DLH. Add the budgeted overhead for the two departments, and divide by the total expected direct labour hours (DLH = 50,000 + 10,000).

2.

Direct materials	$ 20,000
Direct labour	36,000
Overhead ($10 × 6,000 DLH)	60,000
Total manufacturing costs	$116,000
Unit cost ($116,000/10,000)	$ 11.60

3.

Finished Goods	116,000	
Work in Process		116,000
Cost of Goods Sold	116,000	
Finished Goods		116,000
Accounts Receivable	150,800	
Sales Revenue*		150,800

*Sales Revenue = $116,000 + (0.3)($116,000) = $150,800

4. Predetermined rate for Department A: $100,000/50,000 = $2 per DLH
Predetermined rate for Department B: $500,000/50,000 = $10 per machine hour

Direct materials	$20,000
Direct labour	36,000
Overhead:	
Department A: $2 × 5,000	10,000
Department B: $10 × 1,200	12,000
Total manufacturing costs	$78,000
Unit cost ($78,000/10,000)	$ 7.80

Overhead assignment using departmental rates is more accurate because there is a higher correlation with the overhead assigned and the overhead consumed. Notice that Job 10 spends most of its time in Department A, the least overhead intensive of the two departments. Departmental rates reflect this differential time and consumption better than plantwide rates do.

5.

Finished Goods	78,000	
Work in Process		78,000
Cost of Goods Sold	78,000	
Finished Goods		78,000
Accounts Receivable	101,400	
Sales Revenue*		101,400

*Sales Revenue = $78,000 + (0.3)($78,000) = $101,400

Key Terms

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Discussion Questions

1. What is cost measurement? Cost accumulation? What is the difference between the two?
2. Why is actual costing rarely used for product costing?
3. Explain the differences between job-order costing and process costing.
4. What are some differences between a manual job-order costing system and an automated job-order costing system?
5. What is the role of materials requisition forms in a job-order costing system? Time tickets? Predetermined overhead rates?
6. How do firms collect job-related information on driver usage in an activity-based costing system?
7. Explain the role of activity drivers in assigning costs to products.
8. Define the following terms: expected actual activity, normal activity, practical activity, and theoretical activity.
9. Why would some prefer normal activity to expected actual activity to compute a predetermined overhead rate?
10. When using normal costing, how are jobs charged with overhead?
11. Wilson Company has a predetermined overhead rate of $5 per direct labour hour. The job-order cost sheet for Job 145 shows 1,000 direct labour hours costing $10,000 and materials requisitions totalling $7,500. Job 145 had 500 units completed and transferred to Finished Goods Inventory. What is the cost per unit for Job 145?
12. Why are the accounting requirements for job-order costing more demanding than those for process costing?
13. Explain the difference between normal cost of goods sold and adjusted cost of goods sold.
14. Amber Company produces custom framing. For one job, the trainee assigned to cut the mat set the mat dimensions incorrectly into the computer. The mat was unusable and had to be discarded; another mat was cut to the correct dimensions. How is the cost of the spoiled mat handled?
15. Amber Company produces custom framing. For one job, the dimensions of the picture were such that the computer-controlled mat cutting device could not be used. Amber warned the customer that this was a particularly difficult job, and her normal price would be increased to reflect its difficulty. Amber herself cut the mat by hand, but the cut was not as straight as she would have liked. So, she threw out the first mat and cut another one. How is the cost of spoiled mats handled?

Cornerstone Exercises

Cornerstone Exercise 4-1 JOB COSTS USING A PLANTWIDE OVERHEAD RATE

OBJECTIVE 3 4
CORNERSTONE 4-1
SERVICE

Oliphant Company is an R&D company that designs prototypes for clients. Budgeted overhead for the year was $476,000, and budgeted direct labour hours were 13,600. The average wage rate for direct labour is expected to be $25 per hour. During June, Oliphant Company worked on four jobs. Data relating to these four jobs follow:

	Job 39	Job 40	Job 41	Job 42
Beginning balance	$34,500	$23,780	$15,000	$ 0
Materials requisitioned	26,000	13,700	8,350	11,000
Direct labour cost	10,000	18,500	3,000	2,900

Overhead is assigned as a percentage of direct labour cost. During June, Jobs 39 and 40 were completed; Job 39 was sold at 120 percent of cost. (Oliphant had originally developed Job 40 to order for a customer; however, that customer was near bankruptcy and the chance of Oliphant being paid was growing dimmer. Oliphant decided to hold Job

40 in inventory while the customer worked out its financial difficulties. Job 40 is the only job in Finished Goods Inventory.) Jobs 41 and 42 remain unfinished at the end of the month.

Required:

1. Calculate the overhead rate based on direct labour cost.
2. Set up a simple job-order cost sheet for all jobs in process during June.
3. ***What if*** the expected direct labour rate at the beginning of the year was $20 instead of $25? What would the overhead rate be? How would the cost of the jobs be affected?

OBJECTIVE 3 4
CORNERSTONE 4-2
SERVICE

Cornerstone Exercise 4-2 JOB COSTS USING A PLANTWIDE OVERHEAD RATE

Refer to **Cornerstone Exercise 4-1** for data.

Required:

1. Calculate the balance in Work in Process as of June 30.
2. Calculate the balance in Finished Goods as of June 30.
3. Calculate the cost of goods sold for June.
4. Calculate the price charged for Job 39.
5. ***What if*** the customer for Job 40 was able to pay for the job by June 30? What would happen to the balance in Finished Goods? What would happen to the balance of Cost of Goods Sold?

OBJECTIVE 5
CORNERSTONE 4-3

Cornerstone Exercise 4-3 JOB COSTS USING ACTIVITY-BASED COSTING

Beliveau Company is a job-order costing firm that uses activity-based costing to apply overhead to jobs. Beliveau identified three overhead activities and related drivers. Budgeted information for the year is as follows:

Activity	Cost	Driver	Amount of Driver
Materials handling	$ 36,000	Number of moves	3,000
Purchasing	65,000	Number of purchase orders	10,000
Other overhead	280,000	Direct labour hours	20,000

Beliveau worked on four jobs in July. Data are as follows:

	Job 10-43	Job 10-44	Job 10-45	Job 10-46
Beginning balance	$40,800	$41,600	$2,300	$ 0
Direct materials	$15,600	$23,450	$49,000	$9,800
Direct labour cost	$18,000	$20,000	$32,000	$2,400
Number of moves	44	52	29	5
Number of purchase orders	30	40	20	20
Direct labour hours	900	1,000	1,600	120

By July 31, Jobs 10-43 and 10-44 were completed and sold. Job 10-45 was completed but not sold. The remaining job was in process.

Required:

1. Calculate the activity rates for each of the three overhead activities.
2. Prepare job-order cost sheets for each job showing all costs through July 31.
3. Calculate the balance in Work in Process on July 31.
4. Calculate cost of goods sold for July.
5. ***What if*** Job 10-46 required no moves? What is the new cost of Job 10-46? How would the cost of the other jobs be affected?

Cornerstone Exercise 4-4 COST OF NORMAL SPOILAGE

OBJECTIVE 6
CORNERSTONE 4-4
SERVICE

Bastera Company installs granite countertops in customers' homes. First, the customer chooses the particular granite slab, then Bastera measures the countertop area at the customer's home, cuts the granite to that shape, and installs it. The Gavin job calls for direct materials of $2,300 and direct labour of $400. Overhead is applied at the rate of 120 percent of direct labour cost. Unfortunately, one small countertop breaks during installation and Bastera must cut another piece and install it to properly complete the job. The additional rework requires direct materials costing $400 and direct labour costing $100. Assume that the spoilage is due to carelessness by a Bastera worker and is considered to be normal spoilage.

Required:

1. Calculate the cost of the Gavin job.
2. Make any needed journal entry to the overhead control account.
3. ***What if*** the additional rework required $200 of direct labour? What would be the affect on the cost of the Gavin job?

Cornerstone Exercise 4-5 COST OF ABNORMAL SPOILAGE

OBJECTIVE 6
CORNERSTONE 4-4
SERVICE

Refer to the data in **Cornerstone Exercise 4-4**. Assume that the spoilage was due to the inherently fragile nature of the piece of stone picked out by the Gavins. Bastera had warned them that the chosen piece could require much more care and potentially additional work. As a result, Bastera considers this to be abnormal spoilage.

Required:

1. Calculate the cost of the Gavin job.
2. Make any needed journal entry to the overhead control account.
3. ***What if*** the additional rework required $200 of direct labour? What would be the affect on the cost of the Gavin job?

Exercises

Exercise 4-6 CLASSIFYING FIRMS AS EITHER MANUFACTURING OR SERVICE

OBJECTIVE 1
SERVICE

Classify the following types of firms as either manufacturing or service. Explain the reasons for your choice in terms of the four features of service firms (heterogeneity, inseparability, intangibility, and perishability).

a. Bicycle production
b. Pharmaceuticals
c. Income tax preparation
d. Application of artificial nails
e. Glue production
f. Child care

Exercise 4-7 CHARACTERISTICS OF PRODUCTION PROCESS, COST MEASUREMENT

OBJECTIVE 1 2
SERVICE

Elin Saunders, of Lawn Pro Company, designs and installs custom lawn and garden irrigation systems for homes and businesses throughout the province. Each job is different, requiring different materials and labour for installing the systems. Lawn Pro estimated the following for the year:

Number of installations	340
Number of direct labour hours	5,440
Direct material cost	$102,000
Direct labour cost	$54,400
Overhead cost	$59,840

During the year, the following actual amounts were experienced:

Number of installations	290
Number of direct labour hours	4,350
Direct materials used	$87,000
Direct labour incurred	$43,500
Overhead incurred	$53,460

Required:

1. Should Lawn Pro use process costing or job-order costing? Explain.
2. If Lawn Pro uses a normal costing system and overhead is applied on the basis of direct labour hours, what is the cost of an installation that takes $3,500 of direct materials and 30 direct labour hours?
3. Explain why Lawn Pro would have difficulty using an actual costing system.

OBJECTIVE 1 2

SERVICE

Exercise 4-8 CHARACTERISTICS OF PRODUCTION PROCESS, COST MEASUREMENT

Refer to the data in **Exercise 4-7.** Elin Saunders, owner of Lawn Pro, noticed that the watering systems for many houses in a local subdivision had the same layout and required virtually identical amounts of prime cost. Elin met with the subdivision builders and offered to install a basic watering system in each house. The idea was accepted enthusiastically, so Elin created a new company, Irrigation Specialties, to handle the subdivision business. In its first three months in business, Irrigation Specialties experienced the following:

	June	July	August
Number of systems installed	50	65	120
Direct materials used	$15,000	$19,500	$36,000
Direct labour incurred	$10,800	$14,040	$25,920
Overhead	$13,000	$12,025	$10,920

Required:

1. Should Irrigation Specialties use process costing or job-order costing? Explain.
2. If Irrigation Specialties uses an actual costing system, what is the cost of a single watering system installed in June? In July? In August?
3. Now assume that Irrigation Specialties uses a normal costing system. Estimated overhead for the year is $40,000, and estimated production is 500 watering systems. What is the predetermined overhead rate per system? What is the cost of a single system installed in June? In July? In August?

OBJECTIVE 2

Exercise 4-9 ACTIVITY LEVELS USED TO COMPUTE OVERHEAD RATES

Salim Kemal has just started a new business—building and installing custom garage organization systems. Salim builds the cabinets and work benches in his workshop, then installs them in clients' garages. Salim figures his overhead for the coming year will be $9,000. Since his business is labour intensive, he plans to use direct labour hours as his overhead driver. For the coming year, he expects to complete 75 jobs, averaging 20 direct labour hours each. However, he has the capacity to complete 125 jobs averaging 20 direct labour hours each.

Required:

1. Four measures of activity level were mentioned in the text. Which two measures is Salim considering in computing a predetermined overhead rate?
2. Compute the predetermined overhead rates using each of the measures in your answer to Requirement 1.
3. Which one would you recommend that Salim use? Why?

Exercise 4-10 SOURCE DOCUMENTS, JOB COST FLOWS

OBJECTIVE 3 4

Refer to **Exercise 4-9.**

Required:

1. What source documents will Salim need to account for costs in his new business?
2. Suppose Salim's business grows, and he expands his workshop and hires three additional carpenters to help him. What source documents will he need now?

Exercise 4-11 JOB COSTS, ENDING WORK IN PROCESS

OBJECTIVE 4

During March, Aragon Company worked on three jobs. Data relating to these three jobs follow:

	Job 78	Job 79	Job 80
Units in each order	200	180	220
Units sold	—	180	—
Materials requisitioned	$1,560	$990	$2,400
Direct labour hours	220	200	400
Direct labour cost	$3,000	$3,000	$3,300

Overhead is assigned on the basis of direct labour hours at a rate of $8.40 per direct labour hour. During March, Jobs 78 and 79 were completed and transferred to Finished Goods Inventory. Job 79 was sold by the end of the month. Job 80 was the only unfinished job at the end of the month.

Required:

1. Calculate the per-unit cost of Jobs 78 and 79.
2. Compute the ending balance in the work-in-process inventory account.
3. Prepare the journal entries reflecting the completion of Jobs 78 and 79 and the sale of Job 79. The selling price is 140 percent of cost.

Exercise 4-12 PREDETERMINED OVERHEAD RATE, APPLICATION OF OVERHEAD TO JOBS, JOB COST

OBJECTIVE 3 4

On April 1, Sukanya Company had the following balances in its inventory accounts:

Materials Inventory	$12,450
Work-in-Process Inventory	22,605
Finished Goods Inventory	4,600

Work-in-process inventory is made up of three jobs with the following costs:

	Job 114	Job 115	Job 116
Direct materials	$3,650	$1,900	$3,650
Direct labour	1,800	1,560	4,300
Applied overhead	1,350	1,170	3,225

During April, Sukanya experienced the transactions listed below.

a. Materials purchased on account, $26,000.
b. Materials requisitioned: Job 114, $16,500; Job 115, $12,200; and Job 116, $5,000.
c. Job tickets were collected and summarized: Job 114, 350 hours at $12 per hour; Job 115, 280 hours at $15 per hour; and Job 116, 150 hours at $20 per hour.
d. Overhead is applied on the basis of direct labour cost.
e. Actual overhead was $8,718.
f. Job 115 was completed and transferred to the finished goods warehouse.
g. Job 115 was shipped, and the customer was billed.

Required:

1. Calculate the predetermined overhead rate based on direct labour cost.
2. Calculate the ending balance for each job as of April 30.

3. Calculate the ending balance of Work in Process as of April 30.
4. Calculate the cost of goods sold for April.
5. Assuming that Sukanya prices its jobs at cost plus 20 percent, calculate the price of the one job that was sold during April. (Round to the nearest dollar.)

OBJECTIVE 4

Exercise 4-13 JOB COST FLOWS, JOURNAL ENTRIES

Refer to **Exercise 4-12.**

Required:

1. Prepare journal entries for the April transactions.
2. Calculate the ending balances of each of the inventory accounts as of April 30.

OBJECTIVE 2 4

Exercise 4-14 PREDETERMINED OVERHEAD RATE, APPLICATION OF OVERHEAD TO JOBS, JOB COST, UNIT COST

On August 1, Dabo Company's work-in-process inventory consisted of three jobs with the following costs:

	Job 170	Job 171	Job 172
Direct materials	$1,600	$2,000	$850
Direct labour	1,900	1,200	900
Applied overhead	1,710	1,080	810

During August, four more jobs were started. Information on costs added to the seven jobs during the month is as follows:

	Job 170	Job 171	Job 172	Job 173	Job 174	Job 175	Job 176
Direct materials	$1,800	$1,735	$6,550	$4,500	$1,300	$600	$280
Direct labour	1,000	1,400	4,200	1,800	800	860	300

Before the end of August, Jobs 170, 172, 173, and 175 were completed. On August 31, Jobs 172 and 175 were sold.

Required:

1. Calculate the predetermined overhead rate based on direct labour cost.
2. Calculate the ending balance for each job as of August 31.
3. Calculate the ending balance of Work in Process as of August 31.
4. Calculate the cost of goods sold for August.
5. Assuming that Dabo prices its jobs at cost plus 50 percent, calculate Dabo's sales revenue for August.

OBJECTIVE 4

Exercise 4-15 INCOME STATEMENT

Refer to **Exercise 4-14.** Dabo's selling and administrative expenses for August were $1,860.

Required:

Prepare an income statement for Dabo Company for August.

OBJECTIVE 4

Exercise 4-16 JOURNAL ENTRIES, T-ACCOUNTS

Ehrling Brothers Company makes jobs to customer order. During the month of July, the following occurred:

a. Materials were purchased on account for $45,670.
b. Materials totalling $40,990 were requisitioned for use in producing various jobs.
c. Direct labour payroll for the month was $22,400 with an average wage of $14 per hour.
d. Actual overhead of $9,020 was incurred and paid in cash.
e. Manufacturing overhead is charged to production at the rate of $5.50 per direct labour hour.

f. Completed jobs costing $58,000 were transferred to Finished Goods.
g. Jobs costing $59,000 were sold on account for $73,750.

Beginning balances as of July 1 were:

Materials Inventory	$1,200
Work-in-Process Inventory	3,400
Finished Goods Inventory	2,630

Required:

1. Prepare the journal entries for the preceding events.
2. Calculate the ending balances of:
   a. Materials Inventory
   b. Work-in-Process Inventory
   c. Overhead Control
   d. Finished Goods Inventory

Exercise 4-17 UNIT COST, ENDING WORK-IN-PROCESS INVENTORY, JOURNAL ENTRIES

OBJECTIVE 4 5

During August, Skyler Company worked on three jobs. Data relating to these three jobs follow:

	Job 39	Job 40	Job 41
Units in each order	60	100	80
Units sold	—	100	—
Materials requisitioned	$700	$680	$800
Direct labour hours	360	400	200
Direct labour cost	$1,980	$2,480	$1,240

Overhead is assigned on the basis of direct labour hours at a rate of $2.30 per direct labour hour. During August, Jobs 39 and 40 were completed and transferred to Finished Goods Inventory. Job 40 was sold by the end of the month. Job 41 was the only unfinished job at the end of the month.

Required:

1. Calculate the per-unit cost of Jobs 39 and 40. (Round unit costs to nearest cent.)
2. Compute the ending balance in the work-in-process inventory account.
3. Prepare the journal entries reflecting the completion of Jobs 39 and 40 and the sale of Job 40. The selling price is 140 percent of cost.

Exercise 4-18 ACTIVITY-BASED COSTING, UNIT COST, ENDING WORK-IN-PROCESS INVENTORY, JOURNAL ENTRIES

OBJECTIVE 4 5

Feldspar Company uses an ABC system to apply overhead. There are three activity rates:

Setting up	$20 per setup
Machining	$5.10 per machine hour
Other overhead	80% of direct labour cost

During September, Feldspar worked on three jobs. Data relating to these jobs follow:

	Job 10-280	Job 10-281	Job 10-282
Units in each order	200	500	100
Units sold	200	—	100
Materials requisitioned	$4,730	$3,800	$5,600
Direct labour cost	$2,000	$4,600	$800
Machine hours	80	100	40
Number of setups	20	15	25

During September, Jobs 10-280 and 10-282 were completed and transferred to Finished Goods Inventory. Job 10-280 was sold by the end of the month. Job 10-281 was the only unfinished job at the end of the month.

Required:

1. Calculate the per-unit cost of Jobs 10-280 and 10-282. (Round unit cost to nearest cent.)
2. Compute the ending balance in the work-in-process inventory account.
3. Prepare the journal entries reflecting the completion of Jobs 10-280 and 10-282 and the sale of Job 10-280 on account. The selling price is 150 percent of cost.

OBJECTIVE 4

Exercise 4-19 JOURNAL ENTRIES, T-ACCOUNTS

Kapoor Company uses job-order costing. During January, the following data were reported:

a. Materials purchased on account: direct materials, $98,500; indirect materials, $14,800.
b. Materials issued: direct materials, $82,500; indirect materials, $8,800.
c. Labour cost incurred: direct labour, $67,000; indirect labour, $18,750.
d. Other manufacturing costs incurred (all payables), $46,200.
e. Overhead is applied on the basis of 110 percent of direct labour cost.
f. Work finished and transferred to Finished Goods Inventory cost $230,000.
g. Finished goods costing $215,000 were sold on account for 140 percent of cost.
h. Any over- or underapplied overhead is closed to Cost of Goods Sold.

Required:

1. Prepare journal entries to record these transactions.
2. Prepare a T-account for Overhead Control. Post all relevant information to this account. What is the ending balance in this account?
3. Prepare a T-account for Work-in-Process Inventory. Assume a beginning balance of $10,000, and post all relevant information to this account. Did you assign any actual overhead costs to Work-in-Process Inventory? Why or why not?

OBJECTIVE 4 5

Exercise 4-20 ACTIVITY-BASED COSTING, UNIT COST, ENDING WORK-IN-PROCESS INVENTORY

Appleton Company is a job-order costing firm that uses activity-based costing to apply overhead to jobs. Appleton identified three overhead activities and related drivers. Budgeted information for the year is as follows:

Activity	Cost	Driver	Amount of Driver
Engineering design	$156,000	Engineering hours	6,000
Purchasing	96,000	Number of parts	10,000
Other overhead	350,000	Direct labour hours	50,000

Appleton worked on five jobs in March. Data are as follows:

	Job 15	Job 16	Job 17	Job 18	Job 19
Balance, March 1	$34,500	$39,890	$24,090	$0	$0
Direct materials	$28,000	$37,900	$25,350	$11,000	$13,560
Direct labour	$10,000	$8,500	$23,000	$12,900	$8,000
Engineering hours	50	20	40	120	260
Number of parts	150	180	200	500	300
Direct labour hours	650	580	1,600	870	520

By March 31, Jobs 15, 16, and 17 were completed and sold. The remaining jobs were in process.

Required:

1. Calculate the activity rates for each of the three overhead activities.
2. Prepare job-order cost sheets for each job showing all costs through March 31. What is the cost of each job by the end of March?
3. Calculate the balance in Work in Process on March 31.
4. Calculate cost of goods sold for March.

Problems

Problem 4-21 JOURNAL ENTRIES, T-ACCOUNTS, COST OF GOODS MANUFACTURED AND SOLD

OBJECTIVE 4 5

During May, the following transactions were completed and reported by Jerico Company:

a. Materials purchased on account, $60,100.
b. Materials issued to production to fill job-order requisitions: direct materials, $50,000; indirect materials, $8,800.
c. Payroll for the month: direct labour, $75,000; indirect labour, $36,000; administrative, $28,000; sales, $19,000.
d. Depreciation on factory plant and equipment, $10,400.
e. Property taxes on the factory accrued during the month, $1,450.
f. Insurance on the factory expired with a credit to the prepaid insurance account, $6,200.
g. Factory utilities, $5,500.
h. Advertising paid with cash, $7,900.
i. Depreciation on office equipment, $800; on sales vehicles, $1,650.
j. Legal fees incurred but not yet paid for preparation of lease agreements, $750.
k. Overhead is charged to production at a rate of $18 per direct labour hour. Records show 4,000 direct labour hours were worked during the month.
l. Cost of jobs completed during the month, $160,000.

The company also reported the following beginning balances in its inventory accounts:

Materials Inventory	$ 7,500
Work-in-Process Inventory	37,000
Finished Goods Inventory	50,000

Required:

1. Prepare journal entries to record the transactions occurring in May.
2. Prepare T-accounts for Materials Inventory, Overhead Control, Work-in-Process Inventory, and Finished Goods Inventory. Post all relevant entries to these accounts.
3. Prepare a statement of cost of goods manufactured.
4. If the overhead variance is all allocated to cost of goods sold, by how much will cost of goods sold decrease or increase?

Problem 4-22 OVERHEAD APPLICATION, ACTIVITY-BASED COSTING, BID PRICES

OBJECTIVE 4 5

Firenza Company manufactures specialty tools to customer order. Budgeted overhead for the coming year is:

Purchasing	$40,000
Setups	37,500
Engineering	45,000
Other	40,000

Previously, Sanjay Bhatt, Firenza Company's controller, had applied overhead on the basis of machine hours. Expected machine hours for the coming year are 50,000. Sanjay has been reading about activity-based costing, and he wonders whether or not it might offer some advantages to his company. He has decided that appropriate drivers for overhead activities are purchase orders for purchasing, number of setups for setup cost, engineering hours for engineering cost, and machine hours for other. Budgeted amounts for these drivers are 5,000 purchase orders, 500 setups, and 2,500 engineering hours.

Sanjay has been asked to prepare bids for two jobs with the following information:

	Job 1	Job 2
Direct materials	$4,500	$9,340
Direct labour	$1,200	$2,100
Number of purchase orders	15	20
Number of setups	3	4
Number of engineering hours	45	10
Number of machine hours	200	200

The typical bid price includes a 40 percent markup over full manufacturing cost.

Required:

1. Calculate a plantwide rate for Firenza Company based on machine hours. What is the bid price of each job using this rate?
2. Calculate activity rates for the four overhead activities. What is the bid price of each job using these rates?
3. Which bids are more accurate? Why?

OBJECTIVE 3 5

SERVICE

Problem 4-23 PLANTWIDE OVERHEAD RATE, ACTIVITY-BASED COSTING, JOB COSTS

Foto-Fast Copy Shop provides a variety of photocopying and printing services. On June 5, the owner invested in some computer-aided photography equipment that enables customers to reproduce a picture or illustration, input it digitally into the computer, enter text into the computer, and then print out a four-colour professional quality brochure. Prior to the purchase of this equipment, Foto-Fast Copy Shop's overhead averaged $37,500 per year. After the installation of the new equipment, the total overhead increased to $90,000 per year. Foto-Fast Copy Shop has always costed jobs on the basis of actual materials and labour plus overhead assigned using a predetermined overhead rate based on direct labour hours. Budgeted direct labour hours for the year are 7,500, and the wage rate is $8 per hour.

Required:

1. What was the predetermined overhead rate prior to the purchase of the new equipment?
2. What was the predetermined overhead rate after the new equipment was purchased?
3. Suppose Rick Anselm brought in several items he wanted photocopied. The job required 600 sheets of paper at $0.02 each and 45 minutes of direct labour time. What would have been the cost of Rick's job on May 20? On June 20?
4. Suppose that the owner decides to calculate two overhead rates, one for the photocopying area based on direct labour hours as before, and one for the computer-aided printing area based on machine time. Estimated overhead applicable to the computer-aided printing area is $55,000, and forecasted usage of the machines is 2,000 hours. What are the two overhead rates? Which overhead rate system is better—one rate or two?

OBJECTIVE 5

Problem 4-24 PLANTWIDE OVERHEAD RATE VERSUS DEPARTMENTAL RATES, EFFECTS ON PRICING DECISIONS

Cherise Ortega, marketing manager for Romer Company, was puzzled by the outcome of two recent bids. The company's policy was to bid 150 percent of the full manufacturing cost. One job (labelled Job 97-28) had been turned down by a prospective customer, who had indicated that the proposed price was $3 per unit higher than the winning bid. A second job (Job 97-35) had been accepted by a customer, who was amazed that Romer could offer such favourable terms. This customer revealed that Romer's price was $43 per unit lower than the next lowest bid.

Cherise has been informed that the company was more than competitive in terms of cost control. Accordingly, she began to suspect that the problem was related to cost assignment procedures. Upon investigating, Cherise was told that the company uses a

plantwide overhead rate based on direct labour hours. The rate is computed at the beginning of the year using budgeted data. Selected budgeted data are given below.

	Department A	Department B	Total
Overhead	$500,000	$2,000,000	$2,500,000
Direct labour hours	200,000	50,000	250,000
Machine hours	20,000	120,000	140,000

Cherise also discovered that the overhead costs in Department B were higher than those in Department A because B has more equipment, higher maintenance, higher power consumption, higher depreciation, and higher setup costs. In addition to the general procedures for assigning overhead costs, Cherise was supplied with the following specific manufacturing data on Jobs 97-28 and 97-35:

	Job 97-28		
	Department A	Department B	Total
Direct labour hours	5,000	1,000	6,000
Machine hours	200	500	700
Prime costs	$100,000	$20,000	$120,000
Units produced	14,400	14,400	14,400

	Job 97-35		
	Department A	Department B	Total
Direct labour hours	400	600	1,000
Machine hours	200	3,000	3,200
Prime costs	$10,000	$40,000	$50,000
Units produced	1,500	1,500	1,500

Required:

1. Using a plantwide overhead rate based on direct labour hours, develop the bid prices for Jobs 97-28 and 97-35 (express the bid prices on a per-unit basis).
2. Using departmental overhead rates (use direct labour hours for Department A and machine hours for Department B), develop per-unit bid prices for Jobs 97-28 and 97-35.
3. Compute the difference in gross profit that would have been earned had the company used departmental rates in its bids instead of the plantwide rate.
4. Explain why the use of departmental rates in this case provides a more accurate product cost.

Problem 4-25 COST OF SPOILED UNITS

OBJECTIVE 6

SERVICE

Liu Company is a specialty print shop. Usually, printing jobs are priced at standard cost plus 50 percent. Job 2013-631 involved printing 400 wedding invitations with the following standard costs:

Direct materials	$240
Direct labour	60
Overhead	80
Total	$380

Normally, the invitations would be taken from the machine, the top one inspected for correct wording, spelling, and quality of print, and all of the invitations wrapped in plastic and stored on shelves designated for completed jobs. In this case, however, the technician decided to go to lunch before inspecting and wrapping the job. He stacked the unwrapped invitations beside the printing press and left. One hour later, he returned and found that the invitations had fallen on the floor and been stepped on. It turned out that

about 50 invitations were ruined and had to be discarded. An additional 50 invitations were then printed to complete the job.

Required:

1. Calculate the cost of the spoiled invitations. How should the spoilage cost be accounted for?
2. What is the price of Job 2013-631?
3. Suppose that another job, 2013-705, also required 400 wedding invitations. The standard costs were identical to those of Job 2013-631. However, Job 2013-705 required an unusual colour of ink which could only be obtained in a formula that was difficult to use. Liu printers know from experience that getting this ink colour to print correctly requires trial and error. In the case of Job 2013-705, the first 50 invitations had to be discarded due to inconsistencies in the colour of ink. What is the cost of the spoilage, and how would it be treated?
4. What is the price of Job 2013-705?

OBJECTIVE 6

Problem 4-26 COST OF REWORKED UNITS

SERVICE

Warren's Sporting Goods Store sells a variety of sporting goods and clothing. In a back room, Warren's has set up heat-transfer equipment to personalize T-shirts for Little League teams. Typically, each team has the name of the individual player put on the back of the T-shirt. Last week, Shona Kohlmia, coach of the Terrors, brought in a list of names for her team. Her team consisted of 12 players with the following names: Emma, Mary Kate, Sandie, Abda, Aisha, Chania, Zoya, Jennifer, Dayna, Elizabeth, Kyle, and Wendy. Shona was quoted a price of $0.60 per letter.

Chip Russell, Warren's newest employee, was assigned to Shona's job. He selected the appropriate letters, arranged the letters in each name carefully on a shirt, and heat-pressed them on. When Shona returned, she was appalled to see that the names were on the front of the shirts. Jim Warren, owner of the sporting goods store, assured Shona that the letters could easily be removed by applying more heat and lifting them off. This process would ruin the old letters, so new letters would then have to be placed correctly on the shirt backs. He promised to correct the job immediately and have it ready shortly.

Costs for heat-transferring are as follows:

Letters (each)	$0.45
Direct labour (per hour)	8.00
Overhead (per direct labour hour)	4.00

Shona's job originally took one hour and 12 minutes of direct labour time. The removal process goes more quickly and should take only 30 minutes.

Required:

1. What was the original cost of Shona's job?
2. What is the cost of rework on Shona's job? How should the rework cost be treated?
3. How much did Jim Warren charge Shona?

OBJECTIVE 3 4

Problem 4-27 JOB-ORDER COSTING, HOUSING

Sutton Construction Inc. is a privately held, family-founded corporation that builds single- and multiple-unit housing. Most projects Sutton Construction undertakes involve the construction of multiple units. Sutton Construction has adopted a job-order costing system for determining the cost of each unit. The costing system is fully computerized. Each project's costs are divided into the following five categories:

1. *General conditions*, including construction site utilities, project insurance permits and licenses, architect's fees, decorating, field office salaries, and cleanup costs.
2. *Hard costs*, such as subcontractors, direct materials, and direct labour.
3. *Finance costs*, including title and recording fees, inspection fees, and taxes and discounts on mortgages.

4. *Land costs*, which refers to the purchase price of the construction site.
5. *Marketing costs*, such as advertising, sales commissions, and appraisal fees.

Recently, Sutton Construction purchased land for the purpose of developing 20 new single-family houses. The cost of the land was $250,000. Lot sizes vary from ¼ to ½ hectare. The 20 lots occupy a total of eight hectares.

General conditions costs for the project totalled $120,000. This $120,000 is common to all 20 units that were constructed on the building site.

Job 3, the third house built in the project, occupied a ¼-hectare lot and had the following hard costs:

Direct materials	$ 8,000
Direct labour	6,000
Subcontractor	14,000

For Job 3, finance costs totalled $4,765 and marketing costs, $800. General conditions costs are allocated on the basis of units produced. Each unit's selling price is determined by adding 40 percent to the total of all costs.

Required:

1. Identify all production costs that are directly traceable to Job 3. Are all remaining production costs equivalent to overhead found in a manufacturing firm? Are there nonproduction costs that are directly traceable to the housing unit? Which ones?
2. Develop a job-order cost sheet for Job 3. What is the cost of building this house? Did you include finance and marketing costs in computing the unit cost? Why or why not? How did you determine the cost of land for Job 3?
3. Which of the five cost categories corresponds to overhead? Do you agree with the way in which this cost is allocated to individual housing units? Can you suggest a different allocation method?
4. Calculate the selling price of Job 3. Calculate the profit made on the sale of this unit.

Problem 4-28 CASE ON JOB-ORDER COSTING: DENTAL PRACTICE

OBJECTIVE 3 4

SERVICE

Dr. Sherry Biro is employed by Dental Associates. Dental Associates recently installed a computerized job-order costing system to help monitor the cost of its services. Each patient is treated as a job and assigned a job number when he or she checks in with the receptionist. The receptionist-bookkeeper notes the time the patient enters the treatment area and when the patient leaves the area. This difference between the entry and exit times is the number of patient hours used and the direct labour time assigned to the dental assistant. (A dental assistant is constantly with the patient.) The direct labour time assigned to the dentist is 50 percent of the patient hours. (The dentist typically splits her time between two patients.)

The chart filled out by the dental assistant provides additional data that are entered into the computer. For example, the chart contains service codes that identify the nature of the treatment, such as whether the patient received a crown, a filling, or a root canal. The chart identifies not only the type of service but its level as well. For example, if a patient receives a filling, the dental assistant indicates (by a service-level code) whether the filling was one, two, three, or four surfaces. The service and service-level codes are used to determine the rate to be charged to the patient. The costs of providing different services and their levels also vary.

Costs assignable to a patient consist of materials, labour, and overhead. The types of materials used—and the quantity—are identified by the assistant and entered into the computer by the bookkeeper. Material prices are kept on file and accessed to provide the necessary cost information. Overhead is applied on the basis of patient hours. The rate used by Dental Associates is $20 per patient hour. Direct labour cost is also computed using patient hours and the wage rates of the direct labourers. Dr. Biro is paid an average of $36 per hour for her services. Dental assistants are paid an average of $6 per hour. Given the treatment time, the software program calculates and assigns the labour cost for the dentist and her assistant; overhead cost is also assigned using the treatment time and the overhead rate.

The overhead rate does not include a charge for any X-rays. The X-Ray Department is separate from dental services; X-rays are billed and costed separately. The cost of an X-ray is $3.50 per film; the patient is charged $5 per film. If cleaning services are required, cleaning labour costs $9 per patient hour.

Vlad Mirsky, a patient (Job 267), spent 30 minutes in the treatment area and had a two-surface filling. He received two Novocaine shots and used three ampules of amalgam. The cost of the shots was $1. The cost of the amalgam was $3. One X-ray was taken. Other direct materials used are insignificant in amount and are included in the overhead rate. The rate charged to the patient for a two-surface filling is $45.

Required:

1. Prepare a job-order cost sheet for Mirsky. What is the cost for providing a two-surface filling? What is the gross profit earned? Is the X-ray a direct cost of the service? Why are the X-rays costed separately from the overhead cost assignment?
2. Suppose that the patient time and associated patient charges are given for the following fillings:

	1-Surface	2-Surface	3-Surface	4-Surface
Time	20 minutes	30 minutes	40 minutes	50 minutes
Charge	$35	$45	$55	$65

Compute the cost for each filling and the gross profit for each type of filling. Assume that the cost of Novocaine is $1 for all fillings. Ampules of amalgam start at two and increase by one for each additional surface. Assume also that only one X-ray film is needed for all four cases. Does the increase in billing rate appear to be fair to the patient? Is it fair to the dental corporation?

OBJECTIVE 3 4

Problem 4-29 CASE ON JOB-ORDER COSTING AND PRICING DECISIONS

Nutratask Inc. is a pharmaceutical manufacturer of amino-acid-chelated minerals and vitamin supplements. The company was founded in 1974 and is capable of performing all manufacturing functions, including packaging and labouratory functions. Currently, the company markets its products in the United States, Canada, Australia, Japan, and Belgium.

Mineral chelation enhances the mineral's availability to the body, making the mineral a more effective supplement. Most of the chelates supplied by Nutratask are in powder form, but the company has the capability to make tablets or capsules.

The production of all chelates follows a similar pattern. Upon receiving an order, the company's chemist prepares a load sheet (a bill of materials that specifies the product, the theoretical yield, and the quantities of materials that should be used). Once the load sheet is received by production, the materials are requisitioned and sent to the blending room. The chemicals and minerals are added in the order specified and blended together for two to eight hours, depending on the product. After blending, the mix is put on long trays and sent to the drying room, where it is allowed to dry until the moisture content is 7 to 9 percent. Drying time for most products is from one to three days.

After the product is dry, several small samples are taken and sent to a labouratory to be checked for bacterial level and to determine whether the product meets customer specifications. If the product is not fit for human consumption or if it fails to meet customer specifications, additional materials are added under the direction of the chemist to bring the product up to standard. Once the product passes inspection, it is ground into a powder of different meshes (particle sizes) according to customer specifications. The powder is then placed in heavy cardboard drums and shipped to the customer (or, if requested, put in tablet or capsule form and then shipped).

Since each order is customized to meet the special needs of its customers, Nutratask uses a job-order costing system. Recently, Nutratask received a request for a 300-kilogram order of potassium aspartate. The customer offered to pay $8.80/kg. Upon receiving the request and the customer's specifications, Lanny Smith, the marketing manager, requested a load sheet from the company's chemist. The load sheet prepared showed the following material requirements:

Material	Amount Required
Aspartic acid	195.00 kg
Citric acid	15.00 kg
K_2CO_3 (50%)	121.50 kg
Rice	30.00 kg

The theoretical yield is 300 kg.

Lanny also reviewed past jobs that were similar to the requested order and discovered that the expected direct labour time was 16 hours. The production workers at Nutratask earn an average of $6.50 per hour plus $6 per hour for taxes, insurance, and additional benefits.

Purchasing sent Lanny a list of prices for the materials needed for the job.

Material	Price/kg
Aspartic acid	$5.75
Citric acid	2.02
K_2CO_3	4.64
Rice	0.43

Overhead is applied using a companywide rate based on direct labour dollars. The rate for the current period is 110 percent of direct labour dollars.

Whenever a customer requests a bid, Nutratask usually estimates the manufacturing costs of the job and then adds a markup of 30 percent. This markup varies depending on the competition and general economic conditions. Currently, the industry is thriving, and Nutratask is operating at capacity.

Required:

1. Prepare a job-order cost sheet for the proposed job. What is the expected per-unit cost? Should Nutratask accept the price offered by the prospective customer? Why or why not?
2. Suppose Nutratask and the prospective customer agree on a price of cost plus 30 percent. What is the gross profit that Nutratask expects to earn on the job?
3. Suppose that the actual costs of producing 300 kg of potassium aspartate were as follows:

Direct materials:	
Aspartic acid	$1,170.00
Citric acid	30.00
K_2CO_3	577.00
Rice	13.00
Total materials cost	$1,790.00
Direct labour	$ 225.00
Overhead	247.50

   What is the actual per-unit cost? The bid price is based on expected costs. How much did Nutratask gain (or lose) because of the actual costs differing from the expected costs? Suggest some possible reasons why the actual costs differed from the projected costs.
4. Assume that the customer had agreed to pay *actual* manufacturing costs plus 30 percent. Suppose the actual costs are as described in Requirement 3 with one addition: an underapplied overhead variance is allocated to Cost of Goods Sold and spread across all jobs sold in proportion to their total cost (unadjusted cost of goods sold). Assume that the underapplied overhead cost added to the job in question is $30. Upon seeing the addition of the underapplied overhead in the itemized bill, the customer calls and complains about having to pay for Nutratask's inefficient use of overhead costs. If you were assigned to deal with this customer, what kind of response would you prepare? How would you explain and justify the addition of the underapplied overhead cost to the customer's bill?

CMA Problem

CMA Problem 4-1 JOB-ORDER COSTING SYSTEMS*

Aziz Incorporated manufactures furnishings for infants and children. The company uses a normal job-order costing system. Aziz's WIP inventory at April 30, 2013, consisted of the following jobs:

Job Number	Items	Units	Accumulated Cost
CBS102	Cribs	20,000	$ 900,000
PLP086	Playpens	15,000	420,000
DRS114	Dressers	25,000	250,000
			$ 1,570,000

The company's finished goods inventory, using the FIFO method, consisted of five items:

Item	Quantity and Unit Cost	Accumulated Cost
Cribs	7,500 units @ $64 each	$ 480,000
Strollers	13,000 units @ $23 each	299,000
Carriages	11,200 units @ $102 each	1,142,400
Dressers	21,000 units @ $55 each	1,155,000
Playpens	19,400 units @ $35 each	679,000
		$ 3,755,400

Aziz applies factory overhead on the basis of direct labour hours. The company's factory overhead budget for the fiscal year ending May 31, 2012, totalled $4,500,000. The company plans to expend 600,000 direct labour hours during this period. Through the first 11 months of the year, 555,000 direct labour hours were worked and factory overhead totalled $4,273,500.

At the end of April, the balance in Aziz's raw materials inventory account, which includes both raw materials and purchased parts, was $668,000. Additions to and requisitions from raw materials inventory during the month of May included:

	Raw Materials	Purchased Parts
Additions	$242,000	$396,000
Requisitions:		
Job CBS102	51,000	104,000
Job PLP086	3,000	10,800
Job DRS114	124,000	87,000
Job STR077 (10,000 strollers)	2,000	81,000
Job CRG098 (5,000 carriages)	65,000	187,000

During May, Aziz's factory payroll consisted of the following:

Account	Hours	Cost
CBS102	12,000	$122,400
PLP086	4,400	43,200
DRS114	19,500	200,500
STR077	3,500	30,000
CRG098	14,000	138,000
Indirect	3,000	29,400
Supervision		57,600
		$621,100

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The following jobs were completed and sold in May:

Job Number	Items	Quantity
CBS102	Cribs	20,000
PLP086	Playpens	15,000
STR077	Strollers	10,000
CRG098	Carriages	5,000

Items	Quantity Shipped
Cribs	17,500
Playpens	21,000
Strollers	14,000
Dressers	18,000
Carriages	6,000

Required:

1. Describe when it is appropriate for a company to use a job-order cost system.
2. Calculate the dollar balance in Aziz's WIP inventory account as of May 31, 2013.
3. Calculate the dollar amount related to the playpens in Aziz's finished goods inventory as of May 31, 2013.
4. Explain the proper accounting treatment for over- or underapplied overhead balances when using a job-order cost system. *(Adapted from CMA Ontario)*

Research Assignment

OBJECTIVE 1 2 3 4

Research Assignment 4-1 Interview an accountant who works for a service organization that uses job-order costing. For a small firm, you may need to talk to an owner/manager. Examples are a funeral home, insurance firm, repair shop, medical clinic, and dental clinic. Write a paper that describes the job-order costing system used by the firm. Some of the questions that the paper should address are:

a. What service(s) does the firm offer?
b. What document or procedure do you use to collect the costs of the services performed for each customer?
c. How do you assign the cost of direct labour to each job?
d. How do you assign overhead to individual jobs?
e. How do you assign the cost of direct materials to each job?
f. How do you determine what to charge each customer?
g. How do you account for a completed job?

As you write the paper, state how the service firm you investigated adapted the job-order accounting procedures described in this chapter to its particular circumstances. Were the differences justified? If so, explain why. Also, offer any suggestions you might have for improving the approach that you observed.

The Collabourative Learning Exercises can be found on the product support site at www.hancen1ce.nelson.com.

Integrative Exercise 1

Part 1
Chapters 1–4

CableTech Bell Corporation (CTB) operates in the telecommunications industry. CTB has two divisions: the Phone Division and the Cable Service Division. The Phone Division manufactures telephones in several plants located in western Canada. The product lines run from relatively inexpensive touch-tone wall and desk phones to expensive, high-quality cellular phones. CTB also operates a cable TV service in Manitoba. The Cable Service Division offers three products: a basic package with 25 channels; an enhanced package, which is the basic package plus 15 additional channels and two movie channels; and a premium package, which is the basic package plus 25 additional channels and three movie channels.

The Cable Service Division reported the following activity for the month of March:

	Basic	Enhanced	Premium
Sales (units)	50,000	500,000	300,000
Price per unit	$16	$30	$40
Unit costs:			
Directly traced	$ 3	$ 5	$ 7
Driver traced	$ 2	$ 4	$ 6
Allocated	$10	$13	$15

The unit costs are divided as follows: 70 percent production and 30 percent marketing and customer service. Direct labour cost is the only driver used for tracing. Typically, the division uses only production costs to define unit costs. The preceding unit product cost information was provided at the request of the marketing manager and was the result of a special study.

Bryce Yee, the president of CTB, is reasonably satisfied with the performance of the Cable Service Division. March's performance is fairly typical of what has been happening over the past two years. The Phone Division, however, is another matter. Its overall profit performance has been declining. Two years ago, income before income taxes had been about 25 percent of sales. March's dismal performance was also typical for what has been happening this year and is expected to continue—unless some action by management is taken to reverse the trend. During March, the Phone Division reported the following results:

Inventories:	
Materials, March 1	$ 23,000
Materials, March 31	40,000
Work in process, March 1	130,000
Work in process, March 31	45,000
Finished goods, March 1	480,000
Finished goods, March 31	375,000
Costs:	
Direct labour	117,000
Plant and equipment depreciation	50,000
Materials handling	85,000
Inspections	60,000
Scheduling	30,000
Power	30,000
Plant supervision	12,000
Manufacturing engineering	21,000
Sales commissions	120,000
Salary, sales supervisor	10,000
Supplies	17,000
Warranty work	40,000
Rework	30,000

During March, the Phone Division purchased materials totalling $312,000. There are no significant inventories of supplies (beginning or ending). Supplies are accounted for separately from materials. CTB's Phone Division had sales totalling $1,170,000 for March.

Based on March's results, Bryce decided to meet with three of the Phone Division's managers; Violette Leduc, divisional manager; Rajnit Surachi, divisional controller; and Larry Hartley, sales manager. A transcript of their recorded conversation is given next:

Bryce: March's profit performance is down once again, and I think we need to see if we can identify the problem and correct it—before it's too late. Violette, what's your assessment of the situation?

Violette: Foreign competition is eating us alive. They are coming in with lower-priced phones of comparable or higher quality than our own. I've talked with several of the retailers that carry our lines, and they say the same. They are convinced that we can sell more if we lower our prices.

Larry: They're right. If we could lower our prices by 10 to 15 percent, I think that we'd regain most of our lost market share. But we also need to make sure that the quality of our products meets that of our competitors. As you know, we are spending a lot of money each month on rework and warranties. That worries me. I'd like to see that warranty cost cut by 70 to 80 percent. If we could do that, then customers would be more satisfied with our products, and I bet that we would not only regain our market share but increase it.

Rajnit: Lowering prices without lowering per-unit costs will not help us increase our profitability. I think we need to improve our cost accounting system. I am not confident that we really know how much each of our product lines is costing us. It may be that we are overpricing some of our units because we are overcosting them. We may be underpricing other units.

Larry: This sounds promising—especially if the overcosting is for some of our high-volume lines. A price decrease for these products would make the biggest difference—and if we knew they were overcosted, then we could offer immediate price reductions.

Bryce: Rajnit, I need more explanation. We have been using the same cost accounting system for the past 10 years. Why would it be a problem?

Rajnit: I think that our manufacturing environment has changed. Over the years, we have added a lot of different product lines. Some of these products make very different demands on our manufacturing overhead resources. We trace—or attempt to trace—overhead costs to the different products using direct labour cost, a unit-based cost driver. We may be doing more allocation than tracing. If so, then we probably don't have a very good idea of our actual product costs. Also, as you know, with the way computer technology has changed over time, it is easier and cheaper to collect and use detailed information—information that will allow us to assign costs more accurately.

Bryce: This may be something we should explore. Rajnit, what do you suggest?

Rajnit: If we want more accurate product costs and if we really want to get in the cost reduction business, then we need to understand how costs behave. In particular, we need to understand activity cost behaviour. Knowing what activities we perform, why we perform them, and how well we perform them will help us identify areas for improvement. We also need to know how the different products consume activity resources. What this boils down to is the need to use an activity-based management system. But before we jump into this, we need some idea of whether non-unit-based drivers add anything. Activity-based management is not an inexpensive undertaking. So I suggest that we do a preliminary study to see if direct labour cost is adequate for tracing. If not, then maybe some non-unit-drivers might be needed. In fact, if you would like, I can gather some data that will provide some evidence on the usefulness of the activity-based approach.

Bryce: What do you think, Violette? It's your division.

Violette: What Rajnit has said sounds promising. I think he should pursue it and do so quickly. I also think that we need to look at improving our quality. It sounds like we have a problem there. If quality could be improved, then our costs will drop. I'll talk to our quality people. Rajnit, in the meantime, find out for us if moving to an activity-based system is the way to go. How much time do you need?

Rajnit: I have already been gathering data. I could probably have a report within two weeks.

MEMO

TO: Violette Leduc
FROM: Rajnit Surachi
SUBJECT: Preliminary Analysis

Based on my initial analysis, I am confident that an ABC system will offer significant improvement. For one of our conventional phone plants, I regressed total monthly overhead cost on monthly direct labour cost using the following 15 months of data:

Overhead	Direct Labour Cost
$360,000	$110,000
300,000	100,000
350,000	90,000
400,000	100,000
320,000	90,000
380,000	100,000
300,000	90,000
280,000	90,000
340,000	95,000
410,000	115,000
375,000	100,000
360,000	85,000
340,000	85,000
330,000	90,000
300,000	80,000

The results were revealing. Although direct labour cost appears to be a driver of overhead cost, it really doesn't explain a lot of the variation. I then searched for other drivers—particularly non-unit drivers—that might offer more insight into overhead cost behaviour. Every time a batch is produced, material movement occurs, regardless of the size of the batch. The number of moves seemed like a more logical driver. I was able to gather only 10 months of data for this. (Our information system doesn't provide the number of moves, so I had to build the data set by interviewing production personnel.) This information is provided next:

Materials Handling Cost	Number of Moves
$80,000	1,500
60,000	1,000
70,000	1,250
72,000	1,300
65,000	1,100
85,000	1,700
67,000	1,200
73,500	1,350
83,000	1,400
84,000	1,700

The regression results were impressive. There is no question in my mind that the number of moves is a good driver of materials handling costs. Using the number of moves to assign materials handling costs to products would likely be better than the cost assignment using direct labour cost. Furthermore, since small batches use the same number of moves as large batches, we have some evidence that we may be overcosting our high-volume products.

I looked at one more overhead activity: inspecting products. We have 15 inspectors who are paid an average of $4,000 per month. Each inspector offers about 160 hours of inspection capacity per month. However, it appears that they actually work only about 80 percent of those hours. The drop in demand we have experienced explains this idle time. I see no evidence of variable cost behaviour here. I'm not exactly sure how to treat inspection cost, but I think that it is more related to inspection hours than direct labour cost. Some of the other overhead activities seem to be non-unit-level, as well—enough, in fact, to be concerned about how we assign costs.

After receiving the memo, Violette was intrigued. She then asked Rajnit to use the same phone plant as a pilot for a preliminary ABC analysis. She instructed him to assign all overhead costs to the plant's two products (Regular and Deluxe models), using only four activities. The four activities were rework, moving materials, inspecting products, and a general catch-all activity labelled ''other manufacturing activities.'' From the special study already performed, she knew that materials handling and inspecting involved significant cost; from production reports, she also knew that the rework activity involved significant cost. If the ABC and unit-based cost assignments did not differ by breaking out these three major activities, then ABC may not matter.

Pursuant to the request, Rajnit produced the following cost and driver information:

Activity	Expected Cost	Driver	Activity Capacity
Other activities	$2,000,000	Direct labour dollars	$1,250,000
Moving materials	900,000	Number of moves	18,000
Inspecting	720,000	Inspection hours	24,000
Reworking	380,000	Rework hours	3,800
Total overhead cost	$4,000,000		

Expected activity demands:

	Regular Model	Deluxe Model
Units completed	100,000	40,000
Direct labour dollars	$875,000	$375,000
Number of moves	7,200	10,800
Inspection hours	6,000	18,000
Rework hours	1,900	1,900

Required:

1. Compute two different unit costs for each of the Cable Service Division's products. What managerial objectives are being served by these unit cost computations?
2. Three different cost categories are provided by the Cable Service Division: direct tracing, driver tracing, and allocation. Discuss the meaning of each. Based on how costs are assigned, do you think that the Cable Service Division is using a functional-based or an activity-based cost accounting system? What other differences exist between functional-based and activity-based cost accounting systems?
3. Discuss the differences between the Cable Service Division's products and the Phone Division's products.
4. Prepare an income statement for the Cable Service Division for March.
5. Prepare an income statement for the Phone Division for March. Include a supporting cost of goods manufactured statement.
6. The Phone Division has been using the same cost accounting system for over 10 years. Explain why its cost accounting system may be outmoded. What factors determine when a new cost accounting system is warranted?
7. Using the method of least squares, calculate two cost formulas: one for overhead using direct labour cost as the driver, and one for materials handling cost using number of moves as the driver. Comment on Rajnit's observations concerning the outcomes.
8. How would you describe the cost behaviour of the inspection activity? Assume that the quality control manager implements a program that reduces the number of defective units by 50 percent. Because of the improved quality, the demand for inspection hours will also drop by 50 percent. What is the potential monthly reduction in inspection costs? How did knowledge of inspection's cost behaviour help?
9. Calulate the overhead cost per unit for each phone model using direct labour cost to assign all overhead costs to products.

COSTING

Part 2

In order for a manager to make the right decisions in a variety of circumstances, it is essential for that manager to use the proper information. If the costs of a product or service are not calculated properly, the manager can be influenced to make the wrong choices. By making the wrong choices, a manager may be putting his organization at a disadvantage relative to the competition, with very serious consequences.

The cost of a product typically consists of direct material, direct labour, and manufacturing overhead. The definitions of these elements are relatively straightforward; however, in the real world, there can be many choices in terms of how to assign these costs to the product or service being offered. As with choices in any other context, different companies will compute their costs differently, and the impact of the choices used to compute the costs will influence many aspects of the operations of a business.

The process of allocating costs will influence manpower planning decisions, pricing decisions, marketing decisions, expansion or contraction decisions, and many other decisions on a day-to-day basis. Since every organization is different and every management team has to decide how to manage the business, there are many different approaches to assigning costs to a product or a service. Part 2 of this text examines a variety of ways to determine cost, depending on the nature of the company's operations and the purpose of assigning the costs.

After studying this chapter, you should be able to:

- 1 Describe the basic characteristics of process costing, including cost flows, journal entries, and the cost of production report.
- 2 Describe process costing for settings without work-in-process inventories.
- 3 Describe process costing for situations with ending work-in-process inventories.
- 4 Prepare a departmental production report using the FIFO method.
- 5 Prepare a departmental production report using the weighted average method.
- 6 Prepare a departmental production report with transferred-in goods and changes in output measures.
- 7 Describe the basic features of operation costing.
- 8 Explain how spoilage is treated in a process-costing system.

CHAPTER

5 Process Costing

OBJECTIVE 1

Describe the basic characteristics of process costing, including cost flows, journal entries, and the cost of production report.

Basic Operational and Cost Concepts

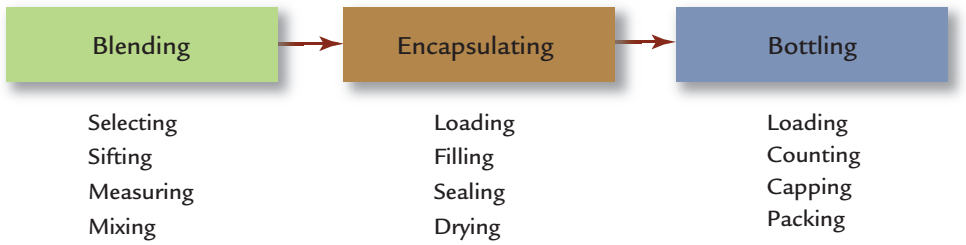
To understand a process-costing system, it is necessary to understand the underlying operational system. An operational process system is characterized by a large number of homogeneous products passing through a series of *processes*, where each process is responsible for one or more operations that bring a product one step closer to completion. Thus, a **process** is a series of activities (operations) that are linked to perform a specific objective. Valeant Pharmaceuticals International Inc. a Mississauga, Ontario-based manufacturer of a wide variety of medications for pain management, cardiovascular disease, neurology, and dermatology, uses process costing in all its plants. For example, its Montreal plant produces a pain management medication using three processes: blending, encapsulating, and bottling. Typically, the blending process consists of four linked activities: selecting, sifting, measuring, and mixing. Direct labourers select the appropriate chemicals (active and inert ingredients) and sift the materials to remove

any foreign substances. Then the materials are *measured* and *combined* in a mixer to blend them thoroughly in the prescribed proportions.

In each process, materials, labour, and overhead inputs may be needed (typically in equal amounts for each unit of product). Upon completion of a particular process, the partially completed goods are transferred to another process. For example, when the mix prepared by the Blending Department is finished, the resulting mixture is sent to the encapsulating process. The encapsulating process consists of four linked activities: loading, filling, sealing, and drying. Initially, the blend and a gelatin mass are loaded into a machine. Two thin ribbons of gel are formed, one on each side of the machine. The mix is fed to a positive displacement pump, which inserts an accurate dose between the two ribbons of gel. The two ribbons are then sealed together using heat and pressure. Finally, the capsules are placed in tumble dryers and then conveyed to a drying room. Once sufficiently dry, they can be sent to bottling. The final process is bottling. It has four linked activities: loading, counting, capping, and packing. Capsules are transferred to this department, loaded into a hopper, and automatically counted into bottles. Filled bottles are mechanically capped, and direct labour then manually packs the correct number of bottles into boxes that are transferred to the warehouse. Exhibit 5-1 summarizes the operational process system for pain management manufacturing.

Exhibit 5-1

An Operational Process System: Pain Management Manufacturing



Cost Flows

The cost flows for a process-costing system are basically similar to those of a job-order costing system. There are two key differences. First, a job-order costing system accumulates production costs by job, and a process-costing system accumulates production costs by process. Second, for manufacturing firms, the job-order costing system uses a single work-in-process (WIP) account, while the process-costing system has a WIP account for every process. Exhibit 5-2 illustrates the first key difference: the different approaches to cost accumulation. Notice that job systems assign manufacturing costs to jobs (which act as subsidiary work-in-process accounts) and transfer these costs directly to the finished goods account when the job is completed. When units are finished for a process, manufacturing costs are transferred from one process department's account to the next. A cost transferred from a prior process to a subsequent process is referred to as a **transferred-in cost**. The last process transfers the costs to Finished Goods. Cornerstone 5-1 reviews the rationale for process cost flows, shows how the cost flows are calculated (without WIP inventories), and shows how journal entries are made.

Cornerstone 5-1 illustrates that when goods are completed in one process, they are transferred with their costs to the subsequent process. Exhibit 5-3 illustrates this transfer of costs using T-accounts. For example, Blending transferred $15,000 of its costs to Encapsulating, and Encapsulating (after further processing) transferred $22,500 of costs to Bottling. These transferred-in costs are (from the viewpoint of the process receiving them) a type of direct materials cost. This is true because the subsequent process receives a partially completed unit that must be subjected to additional manufacturing activity, which includes more direct labour, more overhead, and, in some cases, additional direct materials. For example, the second journal entry for the Encapsulating Department reveals that $7,500 of additional manufacturing costs were added after

Exhibit 5-2

Comparison of Cost Accumulation Methods

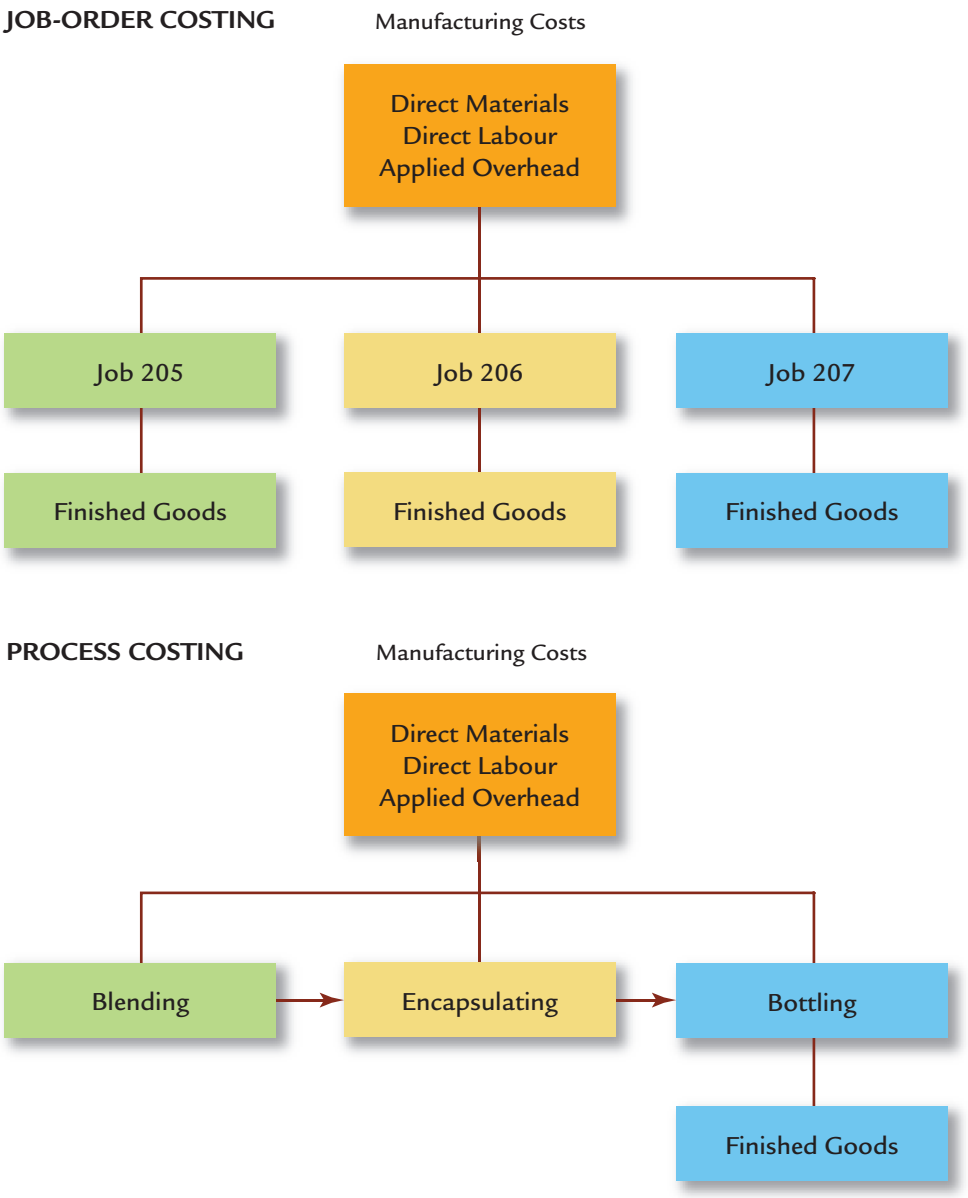


Exhibit 5-3

Process Cost Flows Illustrated Using T-Accounts: No Ending WIP

WIP—Blending			*WIP—Encapsulating*			*WIP—Bottling*			*Finished Goods*	
DM	7,500	15,000		15,000	22,500		22,500	30,000	30,000	
DL	3,500		DM	1,400		DM	3,000			
OH	4,000		DL	2,700		DL	2,000			
			OH	3,400		OH	2,500			

Note: DM = Direct Materials; DL = Direct Labour; OH = Overhead

The HOW and WHY of Cost Flows: Process Costing

CORNERSTONE 5-1

Information:

Rite-Way Pharmaceutical's Lethbridge plant produced 10,000 bottles of pain management medication with the following costs:

	Blending Process	Encapsulating Process	Bottling Process
Direct materials	$7,500	$1,400	$3,000
Direct labour	3,500	2,700	2,000
Applied overhead	4,000	3,400	2,500

Why:

In process costing, each department (process) accumulates its costs in a WIP account. As the work is finished in a process, the partially completed units and all their associated costs are transferred to the next process. Costs are transferred by debiting the WIP account of the process receiving the units while the WIP account of the transferring department is credited.

Required:

1. Calculate the costs transferred out of each department. Assume no WIP inventories.
2. Prepare the journal entries corresponding to these transfers. Also, prepare the journal entry for Encapsulating that reflects the costs added to the transferred-in goods received from Blending.
3. ***What if*** the Blending Department had an ending WIP of $5,000? Calculate the cost transferred out and provide the journal entry that would reflect this transfer. What is the effect on finished goods calculated in the first requirement, assuming the other two departments have no ending WIP?

Solution:

1.

	Blending	Encapsulating	Bottling
Direct materials	$ 7,500	$ 1,400	$ 3,000
Direct labour	3,500	2,700	2,000
Applied overhead	4,000	3,400	2,500
Costs added	15,000	7,500	7,500
Costs transferred in	0	15,000	22,500
Costs transferred out	$15,000	$22,500	$30,000

2. Transfer entries:

Work in Process—Encapsulating	15,000	
Work in Process—Blending		15,000
Work in Process—Bottling	22,500	
Work in Process—Encapsulating		22,500
Finished Goods	30,000	
Work in Process—Bottling		30,000

CORNERSTONE 5-1 *(continued)*

Cost-added entry (Encapsulating only):

Work in Process—Encapsulating	7,500	
Materials		1,400
Payroll		2,700
Overhead Control		3,400

3. The cost transferred out would be $10,000 ($15,000 − $5,000). The journal entry is:

Work in Process—Encapsulating	10,000	
Work in Process—Blending		10,000

Finished goods is reduced by $5,000.

receiving the transferred-in goods from Blending. Thus, while Blending sees the active and inert powders as a combination of direct materials, direct labour, and overhead costs, Encapsulating sees only the powder—a direct material, costing $15,000.

Although a process-costing system has more work-in-process accounts than a job-order costing system, it is a simpler and less expensive system to operate. In a process-costing system, there are no individual jobs, no job-order cost sheets, and no need to track materials to individual jobs. Materials are tracked to processes, but there are far fewer processes than jobs. Furthermore, there is no need to use time tickets for assigning labour costs to processes. Since labourers typically work their entire shift within a particular process, no detailed tracking of labour is needed. In fact, in many firms, labour costs are such a small percentage of total process costs that they are simply combined with overhead costs, creating a conversion cost category.

The Production Report

In process-costing systems, costs are accumulated by department for a period of time. The **production report** is the document that summarizes the manufacturing activity that takes place in a process department for a given period of time. The production report also serves as a source document for transferring costs from the work-in-process account of a prior department to the work-in-process account of a subsequent department. In the department that handles the final stage of processing, it serves as a source document for transferring costs from the work-in-process account to the finished goods account.

A production report provides information about the physical units processed in a department and also about the manufacturing costs associated with them. Thus, a production report is divided into a unit information section and a cost information section. The unit information section has two major subdivisions: (1) units to account for and (2) units accounted for. Similarly, the cost information section has two major subdivisions: (1) costs to account for and (2) costs accounted for. In summary, a production report traces the flow of units through a department, identifies the costs charged to the department, shows the computation of unit costs, and reveals the disposition of the department's costs for the reporting period. One must remember that all costs *must* be accounted for. We cannot omit any costs during the process.

Unit Costs

A key input to the cost of production report is unit costs. In principle, calculating unit costs in a process-costing system is very simple. First, measure the manufacturing costs for a process department for a given period of time. Second, measure the

Exhibit 5-4

Basic Features of a Process-Costing System

1. Homogeneous units pass through a series of similar processes.
2. Each unit in each process receives a similar dose of manufacturing costs.
3. Manufacturing costs are accumulated by a process for a given period of time.
4. There is a work-in-process account for each process.
5. Manufacturing cost flows and the associated journal entries are generally similar to job-order costing.
6. The departmental production report is the key document for tracking manufacturing activity and costs.
7. Unit costs are computed by dividing the departmental costs of the period by the output of the period.

output of the process department for the same period of time. Finally, the unit cost for a process is computed by dividing the costs of the period by the output of the period. The unit cost for the final process is the cost of the fully completed product. Exhibit 5-4 summarizes the basic features of a process-costing system.

While the basic features seem relatively simple, the actual details of process-costing systems are somewhat more complicated. A major source of difficulty is dealing with how costs and output of the period are defined when calculating the unit cost of each process. The presence of significant work-in-process inventories complicates the cost and output definitions needed for the unit cost calculation. For example, partially finished units in the beginning work-in-process inventory carry with them work and costs associated with a prior period. Yet, these units must be finished this period, so they will also have current-period costs and work associated with them. A fundamental question is how to deal with the prior-period costs and work. Another important and related complicating factor is nonuniform application of production costs, i.e., units half completed may not have half of each input needed. Much of our discussion of process-costing systems will deal with the approaches taken to deal with these complicating factors.

Process Costing with No Work-In-Process Inventories

OBJECTIVE 2
Describe process costing for settings without work-in-process inventories.

Perhaps it is best to begin with a discussion of process costing in settings where there are no work-in-process inventories. Seeing how process costing works without work-in-process inventories makes it easier to understand the procedures that are needed to deal with work-in-process inventories. Study of the no-inventory setting is also justified because many service organizations and just-in-time (JIT) manufacturing firms operate in such a setting.

Service Organizations

Services that are basically homogeneous and repetitively produced can take advantage of a process-costing approach. Processing tax returns, sorting mail by postal code, cheque processing in a bank, changing oil, air travel between Toronto and Vancouver, checking baggage, and laundering and pressing shirts are all examples of homogeneous services that are repetitively produced. Although many services consist of a single process, some services require a sequence of processes. Air travel between Toronto and Vancouver, for example, involves the following sequence of services: reservation, ticketing, baggage checking and seat confirmation, flight, and baggage delivery and pickup. Although services cannot be stored, it is possible for firms engaged in service production to have work-in-process inventories. For example, a batch of tax returns can be partially completed at the end of a period. However, many services are provided

CORNERSTONE 5-2

The HOW and WHY of Process Costing: Services with No WIP Inventories

Information:

Picture This specializes in 3D pregnancy sonograms. During the month of April, Picture This had the following cost and output information:

Direct materials	$4,000
Direct labour	$8,000
Overhead	$16,000
Number of sonograms	400

Why:

Theoretically, the current-period unit cost for process costing should use only costs and output that belong to the period. This is expressed as the **process-costing principle:** *To calculate the period's unit cost, divide the costs of the period by the output of the period.*

Required:

1. Calculate the cost per sonogram for April.
2. Calculate the cost of services sold for April.
3. ***What if*** Picture This found a way to reduce material costs by 50 percent? How would this affect the profit per sonogram?

Solution:

1. Unit cost = Costs of the period/Output of the period = $28,000/400 = $70 per sonogram
2. Cost of services sold = Unit cost × Output produced = $70 × 400 = $28,000
3. Reduction in unit cost (profit change) = Savings of the period/Output of the period = $2,000/400 = $5 per sonogram increase in profitability

in such a way that there are no work-in-process inventories. Teeth cleaning, funerals, surgical operations, sonograms, and carpet cleaning are a few examples where work-in-process inventories would be virtually nonexistent. Cornerstone 5-2 illustrates the costing of services using a process-costing approach with no ending work in process (EWIP).

The calculation in Cornerstone 5-2 illustrates the **process-costing principle**, a concept that applies in settings that are more complicated as well.

JIT Manufacturing Firms

Many firms have adopted a just-in-time (JIT) manufacturing approach. The overall thrust of JIT manufacturing is supplying a product that is needed, when it is needed, and in the quantity that is needed. JIT manufacturing emphasizes continuous improvement and the elimination of waste. Since carrying unnecessary inventory is viewed as wasteful, JIT firms strive to minimize inventories. *Successful* implementation of JIT policies tends to reduce work-in-process inventories to insignificant levels. Furthermore, the way manufacturing is carried out in a JIT firm usually is structured so that process costing can be used to determine product costs. Essentially, work cells are created that produce a product or subassembly from start to finish.

Costs are collected by cell for a period of time, and output for the cell is measured for the same period. Unit costs are computed by dividing the costs of the period by output of the period (following the process-costing principle). The computation is identical to that used by service organizations, as illustrated by the sonogram example. Why? Because there is no ambiguity concerning what costs belong to the period and how output is measured. One of the objectives of JIT manufacturing is simplification. Keep this in mind as you study the process-costing requirements of manufacturing firms that carry work-in-process inventories. The difference between the two settings is impressive and demonstrates one of the significant benefits of JIT.

Process Costing with Ending Work-In-Process Inventories

OBJECTIVE 3
Describe process costing for situations with ending work-in-process inventories.

Whenever work-in-process inventories are present, the calculations for process costing become more complicated. The presence of work-in-process inventories creates a need to define more carefully what is meant by a period's output. By definition, ending work in process is not complete. Thus, a unit completed and transferred out during the period is not identical (or equivalent) to one in ending work-in-process inventory, and the cost attached to the two units should not be the same. In computing the unit cost, the output of the period must be defined, taking into consideration both completed units and partially completed units. For example, consider Richardson Testing Centre, a medical laboratory (a service organization), that serves a metropolitan area and several of its outlying communities. The laboratory has several departments, one of which specializes in CBC (complete blood count) tests. Physicians in the region send blood samples to the laboratory. The CBC Department runs the test and inputs the resulting data into the computer so that a statistical analysis can be conducted and a report prepared. During the month of January, 30,000 blood tests were run and analyzed, and reports for completed tests were sent to the referring physicians. These completed tests ("units") were finished and transferred out by mailing the results of the tests to the physicians. Because of the holiday season, the CBC Department rarely has any work in process at the beginning of January. However, at the end of January, there were units (blood samples) that were worked on but not finished, producing an ending work-in-process inventory of 6,000 units, 25 percent complete with respect to all production costs in ending work in process. What is the output in January? 30,000 units? 36,000 units? If we say 30,000 units, then we ignore the effort expended on the units in ending work in process. Furthermore, the production costs incurred in January belong both to the units completed and to the partially completed units in ending work in process. On the other hand, if we say 36,000 units, we ignore the fact that the 6,000 units in ending work in process are only partially completed. Somehow, output must be measured so that it reflects the effort expended on both completed and partially completed units.

Physical Flow and Equivalent Units

The solution is to calculate equivalent units of output. **Equivalent units of output** are the complete units that could have been produced given the total amount of productive effort expended for the period under consideration. Determining equivalent units of output for transferred-out units is easy; a unit would not be transferred out unless it were complete. Thus, every transferred-out unit is one equivalent unit. Units remaining in ending work-in-process inventory, however, are not complete. Someone in production must "eyeball" ending work in process to estimate its degree of completion.

In reality, how the completion rate is calculated is not well documented. In a survey of large Brazilian companies, only about 26 percent indicated that they used the concepts of completion rates and degree of completion. Interestingly, the accounting department was identified as the most frequently specified unit responsible for determining completion levels, followed by production and manufacturing. The survey did not reveal any objective method used for calculating completion levels.[1]

Knowing the physical units in beginning and ending work in process, their stage of completion, and the units completed and transferred out provides essential information for computing the period's equivalent units of output. Thus, the first two steps in building a production report for process costing are (1) the preparation of a **physical flow schedule**, which provides an analysis of the physical flow units, and (2) the calculation of the period's equivalent units. These two steps make up the unit information section of the report. Cornerstone 5-3 illustrates these first two steps.

Calculating Unit Costs, Assigning Costs to Inventories, and Reconciliation

The physical flow and equivalent units schedules are prerequisites to computing the unit cost. Unit cost information and information from the output schedule are both needed to value goods transferred out and goods in ending work in process. Finally, the costs in beginning work in process and the costs incurred during the current period should equal the total costs assigned to goods transferred out and to goods in ending work in process (**cost reconciliation**). Thus, the final three steps needed for a production report are (3) unit cost calculation, (4) valuation of inventories, and (5) cost reconciliation. These last three steps make up the cost information section of the production report. Cornerstone 5-4 illustrates these final three steps.

The Five Steps of the Production Report

Recall that the cost of production report has a unit information section and a cost information section. The unit information section is concerned with output measurement, and the cost information section is concerned with identifying all costs and accounting for them.

As we have shown with the Richardson Testing Centre example, five steps must be followed in preparing a cost of production report:

1. Analysis of the flow of physical units
2. Calculation of equivalent units (period output)
3. Computation of unit cost
4. Valuation of inventories (allocation of costs to WIP and FG inventories)
5. Cost reconciliation

The method and format for preparing this cost of production report is shown in Cornerstone 5-5.

Nonuniform Application of Productive Inputs

Up to this point, we have assumed that work in process being 25 percent complete means that 25 percent of direct materials, direct labour, and overhead needed to complete the process have been used and that another 75 percent are needed to finish the units. In other words, we have assumed that the productive inputs are applied uniformly as the manufacturing process unfolds.

[1] Reinaldo Guerreiro, Edgard Br. Cornachione, and Armando Cartelli, "Equivalent Units of Production: A New Look at an Old Issue, *Managerial Auditing Journal*, Vol. 21, No. 3 (2006): 303–316.

The HOW and WHY of Physical Flow Analysis and Equivalent Units: EWIP Only

CORNERSTONE 5-3

Information:

Richardson Testing Centre had the following data for CBC production for January (output is measured in number of tests):

Units, beginning work in process	—
Units started	36,000
Units completed	30,000
Units, ending work in process (25% complete)	6,000

Why:

A physical flow schedule shows the units to account for and what happened to them. The equivalent units schedule measures the output of the period. A fully completed unit is counted as one unit of output. Output for a unit in ending work in process is counted by its degree of completion. Units completed plus the equivalent units in EWIP (Degree of completion × Units in EWIP) provide a total measure of output for the period.

Required:

1. Prepare a physical flow schedule.
2. Prepare an equivalent units schedule. Explain why output is measured in equivalent units.
3. ***What if*** EWIP is 75 percent complete? How would this change affect the physical flow schedule? The equivalent units schedule?

Solution:

1. Units started and completed = Units completed − Units, BWIP
   = 30,000 − 0 = 30,000
   Units started = Units, EWIP + Units started and completed
   = 6,000 + 30,000 = 36,000

Physical flow schedule:

Units to account for:		
Units in BWIP		0
Units started		36,000
Total units to account for		36,000
Units accounted for:		
Units completed:		
From BWIP	0	
Started and completed	30,000	30,000
Units in EWIP		6,000
Total units accounted for		36,000

2. ***Equivalent units schedule:***

Units completed	30,000
Units in EWIP × Fraction complete:	
6,000 × 0.25	1,500
Equivalent units	31,500

CORNERSTONE 5-3 *(continued)*

Output for the period must take into consideration the work done on units fully completed as well as the work done on partially completed units. Thus, equivalent units become the relevant output measure.

3. Changing the degree of completion does not affect the physical flow schedule. This schedule measures the flow of the units, regardless of their stage of completion. However, the equivalent units schedule is affected. There would now be 4,500 (0.75 × 6,000) equivalent units for EWIP, increasing the total output for the period to 34,500.

CORNERSTONE 5-4

The HOW and WHY of Unit Cost, Inventory Valuation, and Cost Reconciliation: EWIP Only

Information:

For the month of January, Richardson Testing Centre incurred total production costs of $787,500 for processing CBC tests and had the following equivalent units schedule:

Units completed	30,000
Units in EWIP × Fraction complete:	
6,000 × 0.25	1,500
Equivalent units	31,500

Why:

Unit cost is calculated by dividing the cost of the period by the output of the period. The cost of goods (services) transferred out is the unit cost multiplied by the units completed. The cost of EWIP is the unit cost multiplied by the *equivalent units* found in EWIP. Reconciliation is making sure that the costs assigned to goods or services completed and EWIP are equal to the costs to account for.

Required:

1. Calculate the cost of preparing one CBC test for January.
2. Assign costs to tests completed and to EWIP and then do a cost reconciliation.
3. ***What if*** the costs assigned to tests completed and EWIP total $800,000? What are possible reasons for the discrepancy between the costs assigned and the costs to account for?

Solution:

1. Unit cost = $787,500/31,500 = $25 per test
2. Costs assigned:

Tests completed ($25 × 30,000)	$750,000
EWIP ($25 × 1,500)	37,500
Total assigned	$787,500

Reconciliation: The costs assigned equal the costs to account for of $787,500.

3. Since the $800,000 is different than the costs to account for, an error has been made somewhere. Possibilities include calculating the wrong output, using the wrong costs to calculate the unit cost, using the wrong number to calculate the units transferred out or to value EWIP, and simple arithmetic errors.

The HOW and WHY of a Production Report

CORNERSTONE 5-5

Information:
Steps 1 to 5 of the Richardson Testing Centre example, found in Cornerstones 5-3 and 5-4.

Why:
The production report summarizes process manufacturing and costing activity for a given period of time. It is the counterpart of the job-order cost sheet and acts as a subsidiary to the WIP account. The unit information section provides the physical flow and equivalent units schedules. The cost information section shows the unit cost calculation, the amounts assigned to goods transferred out and ending work in process, and provides a cost reconciliation.

Required:
1. What is the purpose of a production report?
2. Prepare a production report for Richardson.
3. ***What if*** the degree of completion is 75 percent for ending work in process? Explain how this would change the production report.

Solution:
1. Since a production report summarizes the manufacturing and costing activity for a given period, it provides information for decision making and control. For example, successive production reports can be used to measure trends in unit costs.
2.

Richardson Testing Centre
Production Report for January

UNIT INFORMATION		
Units to account for:		
Units in beginning work in process	0	
Units started	36,000	
Total units to account for	36,000	
	Physical Flow	***Equivalent Units***
Units accounted for:		
Units completed	30,000	30,000
Units in ending work in process (25% complete)	6,000	1,500
Total units accounted for	36,000	
Work completed		31,500

COST INFORMATION	
Costs to account for:	
Beginning work in process	$ 0
Incurred during the period	787,500
Total costs to account for	$787,500
Divided by equivalent units	÷ 31,500
Cost per equivalent unit	$ 25

CORNERSTONE 5-5 *(continued)*

COST INFORMATION	
Costs accounted for:	
Goods transferred out ($25 × 30,000)	$750,000
Ending work in process ($25 × 1,500)	37,500
Total costs accounted for	$787,500

3. If the degree of completion is 75 percent, the equivalent units in EWIP are 4,500, changing the total equivalent units to 34,500. This, in turn, will change the unit cost from $25 to $22.83 (rounded). The new unit cost will then be used to calculate a new cost of goods transferred out and EWIP.

Assuming uniform application of conversion costs (direct labour and overhead) is not unreasonable. Direct labour input is usually needed throughout the process, and overhead is normally assigned on the basis of direct labour hours. Direct materials, on the other hand, are not as likely to be applied uniformly. In many instances, direct materials are added at either the beginning or the end of the process.

For example, consider the Richardson Testing Centre example. It is more likely that materials (e.g., special chemicals) are added at the beginning of the process rather than uniformly throughout the process. If so, then ending work in process that is 25 percent complete with respect to conversion inputs is 100 percent complete with respect to material inputs.

Different percentage completion figures for productive inputs at the same stage of completion pose a problem for the calculation of equivalent units. Fortunately, the solution is relatively simple. Equivalent units calculations are done for each category of input. Thus, there are equivalent units calculated for *each* category of direct materials and for conversion costs. Unit costs are also calculated for each category, with the total unit cost being the sum of the categories. Cornerstone 5-6 summarizes the rationale and shows how the calculations are done for multiple inputs.

OBJECTIVE 4
Prepare a departmental production report using the FIFO method.

FIFO Costing Method

The presence of beginning work-in-process inventories also complicates output measurement. Since many firms have partially completed units in process at the beginning of a period, there is a clear need to address the issue. The work done on these partially completed units represents prior-period work, and the costs assigned to those units are prior-period costs. In computing a *current-period* unit cost for a department, two approaches have evolved for dealing with the prior-period output and prior-period costs found in beginning work in process: the *first-in, first-out (FIFO) costing method* and the *weighted average method*. Both methods follow the same five steps described for preparing a cost of production report. However, the two methods usually only produce the same result for Step 1. The two methods are best illustrated by example. The FIFO method is discussed first, followed by a discussion of the weighted average method.

The process-costing principle requires that the costs of the period be divided by the output of the period. Thus, theoretically, only *current*-period costs and *current*-period output should be used to compute *current*-period unit costs. The FIFO method attempts to follow this theoretical guideline. Under the **FIFO costing method**, the equivalent units and manufacturing costs in beginning work in process are *excluded* from the current-period unit cost calculation. Thus, the FIFO method recognizes that the work and costs carried over from the prior period legitimately belong to that prior period.

The HOW and WHY of Equivalent Units and Unit Costs with Nonuniform Inputs

CORNERSTONE 5-6

Information:

For the CBC blood tests, Richardson adds materials at the beginning of the process. Conversion costs are added uniformly. For January, EWIP is 25 percent complete with respect to conversion costs. The following information is provided for January:

Physical flow schedule:

Units to account for:		
Units in BWIP		0
Units started		36,000
Total units to account for		36,000
Units accounted for:		
Units completed:		
From BWIP	0	
Started and completed	30,000	30,000
Units in EWIP		6,000
Total units accounted for		36,000

	Inputs	
	Direct Materials	**Conversion**
Costs	$72,000	$715,500

Why:

If materials are added at the beginning or end of a process, then there will be different completion percentages for materials and conversion costs. Typically, conversion costs are added uniformly and materials are added at discrete points in the production process. Assuming conversion is less than 100 percent at a given point in time, then materials added at the beginning are 100 percent complete and materials added at the end are 0 percent complete. Accordingly, equivalent units are calculated for each type of input, and a unit cost is calculated for each input. To calculate the unit cost for each category also requires that costs be accounted for by input category. The unit cost is the sum of the input category unit costs.

Required:

1. Calculate the equivalent units for each input category.
2. Calculate the unit cost for each category and in total.
3. ***What if*** materials are also added at the end of the process, costing $30,000? Let materials added at the beginning be Type 1 materials and those at the end be Type 2 materials. Calculate the new unit cost.

Solution:

1.

	Direct Materials	**Conversion**
Units completed	30,000	30,000
Units EWIP × Fraction complete:		
6,000 × 100%	6,000	
6,000 × 25%	—	1,500
Equivalent units	36,000	31,500

CORNERSTONE 5-6 *(continued)*

2. Unit direct materials cost = $72,000/36,000 = $2.00
   Unit conversion cost = $715,500/31,500 = $22.71 (rounded)
   Total unit cost = Unit direct materials cost + Unit conversion cost = $2.00 + $22.71 = $24.71
3. Now there would be another materials category and a third column of equivalent units:

	Direct Materials (Type 2)
Units completed	30,000
Units EWIP × Fraction complete:	
6,000 × 0%	0
Equivalent units	30,000

Unit materials cost (Type 2) = $30,000/30,000 = $1.00, and the total unit cost would now become $25.71.

Since FIFO excludes prior-period work and costs, we need to create two categories of completed units. FIFO assumes that units in beginning work in process are completed first, before any new units are started. Thus, one category of completed units is that of beginning work-in-process units. The second category is for those units started *and* completed during the current period.

These two categories of completed units are needed in the FIFO method so that each category can be costed separately. For the units started and completed, the unit cost is obtained by dividing total current manufacturing costs by the current-period equivalent output. However, for the beginning work-in-process units, the total associated manufacturing costs are the sum of the prior-period costs plus the costs incurred in the current period to finish the units. Thus, the unit cost is this total cost divided by the units in beginning work in process.

To illustrate the FIFO method, let's return to the Lethbridge plant of Rite-Way Pharmaceuticals, a plant that mass produces a widely used antihistamine medication. Recall that this plant uses three processes: blending, encapsulating, and bottling. Given the May data for the plant's blending operation, the five steps of the FIFO method can be illustrated. The first two steps concern unit-level information and are shown in Cornerstone 5-7. Steps 3 through 5 are concerned with cost information and are illustrated in Cornerstone 5-8.

Cornerstone 5-8 takes the unit information found in Step 2 of Cornerstone 5-7 and combines it with costs incurred in May to calculate a unit cost for May. This unit cost is then used to value ending work in process and calculate the cost of goods transferred out to the Encapsulating Department.

Step 4 of FIFO Revisited

The FIFO method unit costs are used to value output that is related to the *current period*. There are three categories of current-period output: equivalent units in ending work in process, units started and completed, and the equivalent units of work necessary to *finish* the units in beginning work in process.

Since all equivalent units in ending work in process are current-period units, the cost of ending work in process is computed by multiplying the unit cost of each input category by the equivalent units of output for each category: Direct materials ($0.18 × 30,000) and conversion costs ($0.05 × 12,000).

The HOW and WHY of Physical Flow Analysis and Equivalent Units: FIFO Method

CORNERSTONE 5-7

Information:

The production of Rite-Way's pain management medication product begins in the Blending Department. All materials are added at the *beginning* of the blending process. Output is measured in grams. The production data for May are as follows:

Production:	
Units in process, May 1, 70% complete*	15,000
Units completed and transferred out	90,000
Units in process, May 31, 40% complete*	30,000

*With respect to conversion costs.

Why:

The physical flow schedule traces the units in process regardless of their stage of completion and provides the information needed for preparing the equivalent units schedule. FIFO uses only current output to calculate the current-period unit cost. Thus, FIFO treats the work (equivalent output) in BWIP as belonging to the prior period and only counts the work (equivalent output for each input) done this period as part of this period's output.

Required:

1. Prepare a physical flow schedule for May (Step 1).
2. Prepare an equivalent units schedule for May using the FIFO method (Step 2).
3. ***What if*** 80 percent of the materials were added at the beginning of the process and 20 percent were added at the end of the process (assume the same type of materials)? How many equivalent units of materials would there be?

Solution:

1. First, two calculations are needed:

$$\begin{aligned}\text{Units started and completed} &= \text{Units completed} - \text{Units, BWIP}\\ &= 90{,}000 - 15{,}000 = 75{,}000\\ \text{Units started} &= \text{Units started and completed} + \text{Units, EWIP}\\ &= 75{,}000 + 30{,}000 = 105{,}000\end{aligned}$$

Step 1: Physical Flow Schedule: Blending Department

Units to account for:		
Units, beginning work in process (70% complete)		15,000
Units started during May		105,000
Total units to account for		120,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	75,000	
From beginning work in process	15,000	90,000
Units in ending work in process (40% complete)		30,000
Total units accounted for		120,000

CORNERSTONE 5-7 *(continued)*

2. **Step 2: Equivalent Units Schedule: Blending Department**

	Direct Materials	Conversion Costs
Units started and completed	75,000	75,000
Add: Units in beginning work in process × Percentage to complete:		
15,000 × 0% direct materials	—	—
15,000 × 30% conversion costs	—	4,500
Add: Units in ending work in process × Percentage complete:		
30,000 × 100% direct materials	30,000	—
30,000 × 40% conversion costs	—	12,000
Equivalent units of output	105,000	91,500

3. Equivalent units of materials = 75,000 + (0.20 × 15,000) + (0.80 × 30,000) = 102,000

CORNERSTONE 5-8

The HOW and WHY of Unit Cost and Cost Assignment: FIFO

Information:

The equivalent units schedule of Cornerstone 5-7 (Step 2) and the following cost data from the Lethbridge plant's Blending Department for the month of May:

Costs:	
Work in process, May 1:	
Direct materials	$ 1,500
Conversion costs	525
Total work in process	$ 2,025
Current costs:	
Direct materials	$18,900
Conversion costs	4,575
Total current costs	$23,475

Why:

Under FIFO, the costs in BWIP from the prior period are excluded in calculating the unit cost for the current period. The unit cost is the costs of the period divided by the output of the period. *The cost of units transferred out is the sum of three different items:* (1) the costs incurred in the prior period found in BWIP; (2) the costs of completing the BWIP incurred this period; and (3) the costs of the units started and completed this period. Finally, the ending value of EWIP must also be determined.

CORNERSTONE 5-8 *(continued)*

Required:

1. Calculate the unit cost for May, using the FIFO method (Step 3).
2. Calculate the cost of goods transferred out and the cost of EWIP (Step 4). Also, reconcile the costs assigned with the costs to account for (Step 5).
3. ***What if*** you were asked for the unit cost from the month of April? Calculate April's unit cost and explain why this might be of interest to management.

Solution:

1. **Step 3:**

Unit cost = Unit materials cost + Unit conversion cost
= $18,900/105,000 + $4,575/91,500
= $0.18 + $0.05 = $0.23 per gram

2. **Step 4: Valuation of Inventories**

Using unit cost information and the information from the equivalent units schedule (Step 2 of Cornerstone 5-7):

Cost of goods transferred out:	
From BWIP	$ 2,025
To complete BWIP ($0.05 × 4,500)	225
Started and completed ($0.23 × 75,000)	17,250
Total	19,500
EWIP:	
($0.18 × 30,000) + ($0.05 × 12,000)	6,000
Total costs assigned (accounted for)	$25,500

Step 5: Reconciliation (comparing costs assigned to costs to account for)

Costs to account for:	
BWIP	$ 2,025
Current (May)	23,475
Total	$25,500

3. Since materials are added at the beginning, there are 15,000 equivalent units of materials (100% complete); there are 10,500 equivalent units of conversion (0.70 × 15,000). Thus, April unit cost = $1,500/15,000 + $525/10,500 = $0.10 + $0.05 = $0.15. Knowing last month's unit cost allows managers to assess trends in cost and thus exercise better control over costs. If costs are increasing, it may reveal problems that can be corrected. If decreasing, it may reveal that continuous improvement efforts are succeeding.

When it comes to valuing goods transferred out, two categories of completed units must be considered: those that were started and completed and those that were completed from beginning work in process. Of the 90,000 completed units, 75,000 are units started and completed in the current period, and 15,000 are units completed from beginning work in process. The 75,000 units that were started and completed in the current period represent current output and are valued at $0.23 per unit (yielding a cost of $17,250). For these units, the use of the current-period unit cost is entirely appropriate. However, the cost of the 15,000 beginning

work-in-process units that were transferred out is another matter. These units started the period with $2,025 of manufacturing costs already incurred (cost taken from Cornerstone 5-8), 15,000 equivalent units of direct materials already added, and 10,500 equivalent units of conversion activity already completed. To these beginning costs, additional costs were needed to finish the units. As we saw in Cornerstone 5-7, the effort expended to complete these units required an additional 4,500 equivalent units of conversion activity. These 4,500 equivalent units of conversion activity were produced this period at a cost of $0.05 per equivalent unit. Thus, the total cost of finishing the units in beginning work in process is $225 ($0.05 × 4,500). Adding this $225 to the $2,025 in cost carried over from the prior period gives a total manufacturing cost for these units of $2,250. Adding the cost of BWIP units to the units started and completed results in the total cost of goods transferred out.

Production Report and Journal Entries

Steps 1 through 5 of Cornerstones 5-7 and 5-8 provide the information for the May production report based on the FIFO method. This report is shown in Exhibit 5-5. The journal entries associated with the Blending Department (Lethbridge plant) example for the month of May are as follows:

1.	Work in Process—Blending	18,900	
	Materials		18,900
	To record requisitions of materials for May.		
2.	Work in Process—Blending	4,575	
	Conversion Costs—Control		4,575
	To record the application of overhead and the incurrence of direct labour.		
3.	Work in Process—Encapsulating	19,500	
	Work in Process—Blending		19,500
	To record the transfer of cost of goods completed from Blending to Encapsulating.		

OBJECTIVE 5
Prepare a departmental production report using the weighted average method.

Weighted Average Costing Method

Dealing separately with prior-period work and costs creates some bookkeeping and computational complexity that can be avoided if certain conditions are satisfied. Specifically, if the costs of production remain very stable from one period to the next, then it may be possible to use the weighted average method. This method does not track prior-period output and costs separately from current-period output and costs. The **weighted average costing method** picks up beginning inventory costs and the accompanying equivalent output and treats them as if they belong to the current period. Prior-period output and manufacturing costs found in beginning work in process are merged with the current-period output and manufacturing costs.

The merging of beginning inventory output and current-period output is accomplished by the way in which equivalent units are calculated. Under the weighted average method, equivalent units of output are computed by adding units completed to equivalent units in ending work in process. The equivalent units in beginning work in process are included in the computation. Thus, these units are counted as part of the current period's equivalent units of output.

The weighted average method merges prior-period costs with current-period costs by simply adding the manufacturing costs in beginning work in process to the manufacturing costs incurred during the current period. The total cost is treated as if it were the current period's total manufacturing cost.

The illustration of the weighted average method is based on the same Rite-Way Pharmaceuticals data that were used to illustrate the FIFO method. Using the same data highlights the differences between the two methods. The five steps for costing out production follow. Cornerstone 5-9 shows the first two steps for the weighted average method, and Cornerstone 5-10 illustrates Steps 3 to 5.

Exhibit 5-5

Production Report: Blending Department

Rite-Way Pharmaceuticals, Lethbridge Plant
Blending Department
Production Report for May
(FIFO Method)

UNIT INFORMATION

Units to account for:		Units accounted for:	
Units, beginning work in process	15,000	Units completed	90,000
Units started	105,000	Units, ending work in process	30,000
Total units to account for	120,000	Total units accounted for	120,000

	Equivalent Units	
	Direct Materials	Conversion Costs
Units started and completed	75,000	75,000
Units, beginning work in process	—	4,500
Units, ending work in process	30,000	12,000
Equivalent units of output	105,000	91,500

COST INFORMATION

	Direct Materials	Conversion Costs	Total
Costs to account for:			
Beginning work in process	$ 1,500	$ 525	$ 2,025
Incurred during the period	18,900	4,575	23,475
Total costs to account for	$ 20,400	$ 5,100	$25,500
Cost per equivalent unit:			
Current period costs	$ 18,900	$ 4,575	
Divided by equivalent units	÷105,000	÷91,500	
Cost per equivalent unit	$ 0.18	$ 0.05	$ 0.23
Costs accounted for:			
Units transferred out:			
Units, beginning work in process:			
From prior period		$ 2,025	
From current period ($0.05 × 4,500)		225	
Units started and completed ($0.23 × 75,000)		17,250	$19,500
Ending work in process:			
Direct materials ($0.18 × 30,000)		5,400	
Conversion costs ($0.05 × 12,000)		600	6,000
Total costs accounted for			$25,500

Production Report

Steps 1 through 5 shown in Cornerstones 5-9 and 5-10 provide all of the information needed to prepare a production report for the Blending Department for May. This report is given in Exhibit 5-6. The journal entries for the weighted average method follow the same pattern shown for the FIFO method. Thus, there is no reason to repeat the entries.

Exhibit 5-6

Production Report: Blending Department

Rite-Way Pharmaceuticals, Lethbridge Plant
Blending Department
Production Report for May
(Weighted Average Method)

UNIT INFORMATION

Units to account for:		Units accounted for:	
Units, beginning work in process	15,000	Units completed	90,000
Units started	105,000	Units, ending work in process	30,000
Total units to account for	120,000	Total units accounted for	120,000

	Equivalent Units	
	Direct Materials	Conversion Costs
Units completed	90,000	90,000
Units, ending work in process	30,000	12,000
Equivalent units of output	120,000	102,000

COST INFORMATION

	Direct Materials	Conversion Costs	Total
Costs to account for:			
Beginning work in process	$ 1,500	$ 525	$ 2,025
Incurred during the period	18,900	4,575	23,475
Total costs to account for	$ 20,400	$ 5,100	$25,500
Divided by equivalent units	÷120,000	÷102,000	
Cost per equivalent unit	$ 0.17	$ 0.05	$ 0.22

Costs accounted for:		
Units transferred out ($0.22 × 90,000)		$19,800
Ending work in process:		
Direct materials ($0.17 × 30,000)	$5,100	
Conversion costs ($0.05 × 12,000)	600	5,700
Total costs accounted for		$25,500

FIFO Compared with Weighted Average

The FIFO and weighted average methods differ on two key dimensions: (1) how output is computed and (2) what costs are used for calculating the period's unit cost. The unit cost computation for the Blending Department is as follows:

	FIFO		Weighted Average	
	Direct Materials	Conversion Costs	Direct Materials	Conversion Costs
Costs	$ 18,900	$ 4,575	$ 20,400	$ 5,100
Output (units)	÷105,000	÷91,500	÷120,000	÷102,000
Unit cost	$ 0.18	$ 0.05	$ 0.17	$ 0.05

The HOW and WHY of Physical Flow Analysis and Equivalent Units: Weighted Average Method

CORNERSTONE 5-9

Information:

The production of Rite-Way's pain management medication product begins in the Blending Department. All materials are added at the *beginning* of the blending process. Output is measured in grams. The production data for May are as follows:

Production:	
Units in process, May 1, 70% complete*	15,000
Units completed and transferred out	90,000
Units in process, May 31, 40% complete*	30,000

*With respect to conversion costs.

Why:

The physical flow schedule traces the units in process regardless of their stage of completion. To calculate equivalent units, weighted average counts prior-period output in BWIP as belonging to the current period. Thus, all completed units are treated as output of the current period. There is no requirement to calculate the work needed to complete the units in BWIP. Once weighted average equivalent units are calculated, the FIFO equivalent units can be obtained by subtracting out the prior-period output found in BWIP.

Required:

1. Prepare a physical flow schedule for May (Step 1).
2. Prepare an equivalent units schedule for May using the weighted average method. (Step 2).
3. ***What if*** a need surfaced to know the FIFO equivalent units? Calculate the FIFO equivalent units starting with the weighted average equivalent units.

Solution:

1. First, two calculations are needed:

$$\begin{aligned}\text{Units started and completed} &= \text{Units completed} - \text{Units, BWIP}\\ &= 90{,}000 - 15{,}000 = 75{,}000\\ \text{Units started} &= \text{Units started and completed}\\ &\quad + \text{Units, EWIP}\\ &= 75{,}000 + 30{,}000 = 105{,}000\end{aligned}$$

Step 1: Physical Flow Schedule: Blending Department

Units to account for:		
Units, beginning work in process (70% complete)		15,000
Units started during May		105,000
Total units to account for		120,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	75,000	
From beginning work in process	15,000	90,000
Units in ending work in process (40% complete)		30,000
Total units accounted for		120,000

CORNERSTONE 5-9 (continued)

2. **Step 2: Equivalent Units Schedule: Blending Department**

	Direct Materials	Conversion Costs
Units completed	90,000	90,000
Add: Units in ending work in process × Percentage complete:		
30,000 × 100% direct materials	30,000	—
30,000 × 40% conversion costs	—	12,000
Equivalent units of output	120,000	102,000

3.

	Direct Materials	Conversion Costs
Weighted average equivalent units of output	120,000	102,000
Less equivalent units in BWIP	15,000	10,500
FIFO equivalent units	105,000	91,500

CORNERSTONE 5-10

The HOW and WHY of Unit Cost and Cost Assignment: Weighted Average Method

Information:

The equivalent units schedule of Cornerstone 5-9 (Step 2) and the following cost information from the Lethbridge plant's Blending Department for the month of May:

Costs:	
Work in process, May 1:	
Direct materials	$ 1,500
Conversion costs	525
Total work in process	$ 2,025
Current costs:	
Direct materials	$18,900
Conversion costs	4,575
Total current costs	$23,475

Why:

The weighted average method counts prior-period work and costs in BWIP as if they belong to the current-period; thus, the unit cost is obtained by dividing the sum of the costs in BWIP and the current-period costs by the weighted average equivalent output. The resulting unit cost is a blend of the prior-period unit cost and the actual current-period unit cost. The valuation of cost of goods transferred out is simplified as it is the total unit cost multiplied by the units completed.

CORNERSTONE 5-10 *(continued)*

Required:

1. Calculate the unit cost for May, using the weighted average method (Step 3).
2. Calculate the cost of goods transferred out and the cost of EWIP (Step 4). Also, reconcile the costs assigned with the costs to account for (Step 5).
3. ***What if*** you were asked to show that the weighted average unit cost for materials is the blend of the April unit materials cost and the May unit materials cost? From Cornerstone 5-8, we know that the April unit materials cost is $0.10 and the May unit materials cost is $0.18. The equivalent units in BWIP are 15,000, and the FIFO equivalent units are 105,000. Calculate the weighted average unit materials cost using weights defined as the proportion of total units completed from each source (BWIP output and current output).

Solution:

1. **Step 3:**

	Direct Materials	Conversion Costs
Costs:		
BWIP	$ 1,500	$ 525
Current	18,900	4,575
	$ 20,400	$ 5,100
Equivalent Units:		
Completed	$ 90,000	$ 90,000
EWIP	30,000	12,000
	$120,000	$102,000

$$\text{Unit cost} = \text{Unit materials cost} + \text{Unit conversion cost}$$
$$= (\$1{,}500 + \$18{,}900)/120{,}000 + (\$525 + \$4{,}575)/102{,}000$$
$$= \$0.17 + \$0.05 = \$0.22 \text{ per gram}$$

2. **Step 4: Valuation of Inventories**
Using unit cost information and the information from the equivalent units schedule (Step 2 of Cornerstone 5-9):

Cost of goods transferred out:	
Units completed ($0.22 × 90,000)	$19,800
EWIP:	
($0.17 × 30,000) + ($0.05 × 12,000)	5,700
Total costs assigned (accounted for)	$25,500

Step 5: Reconciliation (comparing costs assigned to costs to account for)

Costs to account for:	
BWIP	$ 2,025
Current (May)	23,475
Total	$25,500

3. $$\text{Unit materials cost} = (15{,}000/120{,}000)\$0.10 + (105{,}000/120{,}000)\$0.18$$
$$= \$0.17$$

The two methods use different total costs and different measures of output. The FIFO method is the more theoretically appealing because it divides the cost of the period by the output of the period. The weighted average method, however, merges costs in beginning work in process with current-period costs and merges the output found in beginning work in process with current-period output. This creates the possibility for errors—particularly if the weighted average method is used for situations where input costs are changing significantly from one period to the next.

In the Blending Department example, the FIFO method unit cost and the weighted average method unit cost for conversion costs are the same; evidently, the cost of this input remained the same for the two periods being considered. The unit direct materials cost for the FIFO method, however, is $0.18 versus $0.17 for the weighted average method. Apparently, the cost of direct materials has increased, and merging the lower direct materials cost of the prior period with that of the current period creates a weighted average direct materials cost that underestimates the current-period direct materials cost. The resulting difference in the cost of a fully completed unit is only $0.01 ($0.23 − $0.22). On the surface, this seems harmless.

The difference in the costs reported under each method for goods transferred out and the ending work-in-process inventories is only $300 (see Exhibits 5-5 and 5-6). This is a less than 2 percent difference for goods transferred out and only about a 5 percent difference for ending work in process. The $0.01 unit cost difference does not appear to be material. Yet, if the final product is considered, even a $0.01 difference may be significant. Recall that Rite-Way passes the powder from the Blending Department to the Encapsulating Department, where the powder is converted to capsules. Next, the capsules are sent to the Bottling Department where eight capsules are placed in small bottles. The output of the Blending Department is measured in units of 10 grams each. Suppose that 40 grams of powder convert to eight capsules. The difference in the cost of the final product would be understated by $0.04—not $0.01. Using this unit cost information may produce erroneous decisions such as under- or overpricing. Furthermore, if the other two departments also use the weighted average method, the costs in those departments could also be understated. The cumulative effect could produce a significant distortion in cost for the final product—magnifying the effect.

A second disadvantage of weighted average costing should be mentioned as well. The weighted average method also combines the performance of the current period with that of a prior period. Often, it is desirable to exercise control by comparing the actual costs of the current period with the budgeted or standard costs for the period. The weighted average method makes this comparison suspect because the performance of the current period is not independent of the prior period.

The major benefit of the weighted average method is simplicity. When all units in beginning work in process are treated as belonging to the current period, all equivalent units belong to the same time period when it comes to calculating unit costs. As a consequence, the requirements for computing unit cost are greatly simplified. Yet, as has been discussed, accuracy and performance measurement are impaired. The FIFO method overcomes both of these disadvantages. It should be mentioned, however, that both methods are widely used. Perhaps we can conclude that there are many settings in which the distortions caused by the weighted average method are not serious enough to be of concern.

OBJECTIVE 6

Prepare a departmental production report with transferred-in goods and changes in output measures.

Treatment of Transferred-In Goods

In process manufacturing, some departments invariably receive partially completed goods from prior departments. For example, under the FIFO method, the transfer of goods from Blending to Encapsulating is valued at $19,500. These transferred-in goods are a type of direct material for the subsequent process—materials that are added at the beginning of the subsequent process. The usual approach is to treat transferred-in goods as a separate material category when calculating equivalent units (the what-if question of Cornerstone 5-6 illustrates the possibility of multiple material

categories). Thus, we now have three categories of manufacturing inputs: transferred-in materials, direct materials added, and conversion costs. For the Rite-Way Pharmaceuticals example, Encapsulating receives transferred-in materials, a powdered mixture, from Blending, loads the powder into gelatin capsules (a material added), seals the capsules, and dries them. The process uses labour and overhead to convert the powder into capsules.

In dealing with transferred-in goods, three important points should be remembered. First, the cost of this material is the cost of the goods transferred out computed in the prior department. Second, the units started in the subsequent department correspond to the units transferred out from the prior department, assuming that there is a one-to-one relationship between the output measures of both departments. Third, the units of the transferring department may be measured differently than the units of the receiving department. If this is the case, then the goods transferred in must be converted to the units of measure used by the second department.

To illustrate how process costing works for a department that receives transferred-in work, we will use the Encapsulating Department of Rite-Way's Lethbridge plant. The Encapsulating Department receives a powder from Blending and fills capsules with the powder. The units of the Blending Department are measured in 100 gram units, and the units of the Encapsulating Department are measured in capsules. To convert grams to capsules, we need to know the relationship between grams and capsules. Every 100 grams of the transferred-in mix converts to 4.4 capsules. Thus, to convert the transferred-in materials to the new output measure, multiply the transferred-in units by 4.4.

Now let's consider the month of May for the Lethbridge plant and focus our attention on the Encapsulating Department. We will assume that the Lethbridge plant uses the weighted average method. May's cost and production data for the Encapsulating Department are given in Exhibit 5-7. Notice that the transferred-in cost for May is the Mixing Department's transferred-out cost. (Exhibit 5-6 shows that the Mixing Department transferred out 90,000 100 gram units of powder, costing $19,800.) Also notice that output for the Encapsulating Department is measured in capsules. Given the data in Exhibit 5-7, the five steps of process costing can be illustrated for the Encapsulating Department.

Exhibit 5-7

Production and Cost Data: Encapsulating Department

Rite-Way Pharmaceuticals, Lethbridge Plant
Encapsulating Department
Production and Cost Data for May

Production:	
Units in process, May 1, 80% complete[a]	24,000 (capsules)
Units completed and transferred out	375,000
Units in process, May 31, 30% complete*	45,000
Costs:	
Work in process, May 1:	
Transferred-in costs	$1,200
Direct materials (gelatin capsules)	450
Conversion costs	270
Total work in process	$1,920
Current costs:	
Transferred-in costs	$19,800
Direct materials (gelatin capsules)[b]	3,750
Conversion costs	7,500
Total current costs	$31,050

[a] With respect to conversion costs. Direct materials are 100 percent complete because they are added at the beginning of the process.
[b] The cost of capsule coating materials is insignificant and therefore added to the conversion costs category.
* With respect to conversion costs.

Step 1: Physical Flow Schedule In constructing a physical flow schedule for the Encapsulating Department, its dependence on the Blending Department must be considered:

Units to account for:		
Units, beginning work in process		24,000
Units transferred in during May		396,000*
Total units to account for		420,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	351,000	
From beginning work in process	24,000	375,000
Units, ending work in process		45,000
Total units accounted for		420,000

*90,000 × 4.4 (converts transferred-in units from 100 grams to capsules)

Step 2: Calculation of Equivalent Units The calculation of equivalent units of production using the weighted average method is shown in Exhibit 5-8. Notice that the transferred-in goods from Blending are treated as materials added at the beginning of the process. Transferred-in materials are always 100 percent complete, since they are added at the beginning of the process.

Step 3: Computation of Unit Costs The unit cost is computed by calculating the unit cost for each input category:

$$\begin{aligned}\text{Unit transferred-in cost} &= (\$1{,}200 + \$19{,}800)/420{,}000 = \$0.05\\ \text{Unit direct materials cost} &= (\$450 + \$3{,}750)/420{,}000 = \$0.01\\ \text{Unit conversion costs} &= (\$270 + \$7{,}500)/388{,}500 = \$0.02\\ \text{Total unit cost} &= \$0.05 + \$0.01 + \$0.02\\ &= \$0.08\end{aligned}$$

Step 4: Valuation of Inventories The cost of goods transferred out is simply the total unit cost multiplied by the goods completed:

$$\text{Cost of goods transferred out} = \$0.08 \times 375{,}000 = \$30{,}000$$

Costing out ending work in process is done by computing the cost of each input and then adding to obtain the total:

Transferred-in materials: $0.05 × 45,000	$2,250
Direct materials added: $0.01 × 45,000	450
Conversion costs: $0.02 × 13,500	270
Total	$2,970

Exhibit 5-8

Equivalent Units of Production: Weighted Average Method

	Transferred-In Materials	Direct Materials Added	Conversion Costs
Units completed	375,000	375,000	375,000
Add: Units in ending work in process × Percentage complete:			
45,000 × 100%	45,000	—	—
45,000 × 100%	—	45,000	—
45,000 × 30%	—	—	13,500
Equivalent units of output	420,000	420,000	388,500

Exhibit 5-9

Production Report: Encapsulating Department

Rite-Way Pharmaceuticals, Lethbridge Plant
Encapsulating Department
Production Report for May
(Weighted Average Method)

UNIT INFORMATION

Units to account for:		Units accounted for:	
Units, beginning work in process	24,000	Units completed	375,000
Units started	396,000	Units, ending work in process	45,000
Total units to account for	420,000	Total units accounted for	420,000

	Equivalent Units		
	Transferred-In Materials	Direct Materials	Conversion Costs
Units completed	375,000	375,000	375,000
Units, ending work in process	45,000	45,000	13,500
Equivalent units of output	420,000	420,000	388,500

COST INFORMATION

	Transferred-In Materials	Direct Materials	Conversion Costs	Total
Costs to account for:				
Beginning work in process	$ 1,200	$ 450	$ 270	$ 1,920
Incurred during the period	19,800	3,750	7,500	31,050
Total costs to account for	$ 21,000	$ 4,200	$ 7,770	$32,970
Divided by equivalent units	÷420,000	÷420,000	÷388,500	
Cost per equivalent unit	$ 0.05	$ 0.01	$ 0.02	$ 0.08

Costs accounted for:		
Units transferred out ($0.08 × 375,000)		$30,000
Ending work in process:		
Transferred-in materials ($0.05 × 45,000)	$2,250	
Direct materials ($0.01 × 45,000)	450	
Conversion costs ($0.02 × 13,500)	270	2,970
Total costs accounted for		$32,970

The cost of production report for the Encapsualting Department for the month of May, including Step 5 (which was skipped), is shown in Exhibit 5-9.

The only additional complication introduced in the analysis for a subsequent department is the presence of the transferred-in category. As we have just shown, dealing with this category is similar to handling any other category. However, remember that the current cost of this special type of material is the cost of the units transferred in from the prior process and that the units transferred in are the units started (adjusted for any differences in output measurement).

Operation Costing

OBJECTIVE 7
Describe the basic features of operation costing.

Not all manufacturing firms have a pure job production environment or a pure process production environment. Some manufacturing firms have characteristics of both job and process environments. Firms in these *hybrid* settings often use *batch production processes*. **Batch production processes** produce batches of different products that

are identical in many ways but differ in others. In particular, many firms produce products that make virtually the same demands on conversion inputs but different demands on direct materials inputs. Thus, the conversion activities are similar or identical, but the direct materials used are significantly different. For example, the conversion activities required to produce cans of pie filling are essentially identical for apple or cherry pie filling, but the cost of the direct materials can differ significantly. Similarly, the conversion activities for women's skirts may be identical, but the cost of direct materials can differ dramatically, depending on the nature of the fabric used (wool versus polyester, for example). Clothes, textiles, shoes, and food industries are examples where batch production may take place. For these firms, a costing system known as *operation costing* is often adopted.

Basics of Operation Costing

Operation costing is a blend of job-order and process-costing procedures applied to batches of homogeneous products. This costing system uses *job-order procedures* to assign direct materials costs to batches and *process procedures* to assign conversion costs. A hybrid costing approach is used because each batch uses different doses of direct materials but makes the same demands on the conversion resources of individual processes (usually called operations). Although different batches may pass through different operations, the demands for conversion activities for the *same* process do not differ among batches.

Work orders are used to collect production costs for each batch. Work orders also are used to initiate production. Using work orders to initiate and track costs to each batch is a job-costing characteristic. However, since individual products of different batches consume the same conversion resources as they pass through the same operation, then each product (regardless of batch membership) can be treated as a single homogeneous unit. This last trait is a process-costing characteristic and can be exploited to simplify the assignment of conversion costs.

Materials requisition forms are used to identify the direct materials, quantity and prices, and work order number. Using the materials requisition form as the source document, the cost of direct materials is posted to the work order sheet. Conversion costs are collected by *process* and assigned to products using a *predetermined conversion rate* (identical in concept to predetermined overhead rates). Conversion costs are budgeted for each department, and a single conversion rate is computed for each department (process) using a unit-based activity driver such as direct labour hours or machine hours. For example, assume that the budgeted conversion costs for a sewing operation are $100,000 (consisting of items such as direct labour, depreciation, supplies, and power), and the practical capacity of the operation is 10,000 machine hours. The conversion rate is computed as follows:

$$\begin{aligned}\text{Conversion rate} &= \$100{,}000/10{,}000 \text{ machine hours} \\ &= \$10 \text{ per machine hour}\end{aligned}$$

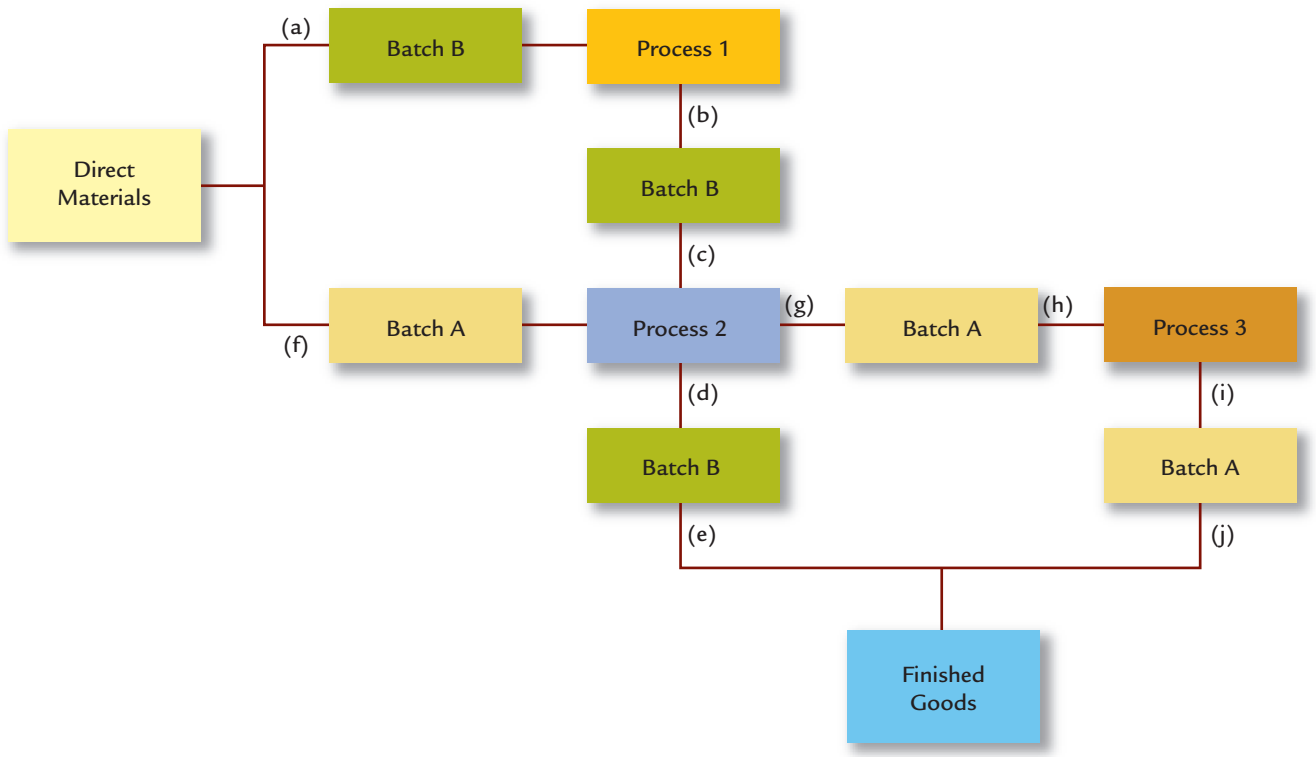
Now consider two batches of shoes that pass through the sewing operation: one batch consists of 50 pairs of men's leather boots, and the second batch consists of 50 pairs of women's leather sandals. First, it should be clear that the batches have different direct material requirements so the cost of direct materials should be tracked separately (job-costing feature). Second, it should also be obvious that the sewing activity is the same for each in the sense that one hour of sewing time should consume the same resources regardless of whether the product is boots or sandals (the process-costing feature). If the batch of boots takes 25 machine hours, the batch will be assigned $250 of conversion costs ($10 $\times$ 25 hours). If the batch of sandals takes 12 machine hours, it will be assigned $120 of conversion costs ($10 $\times$ 12). Again, even though the products consume the same resources per machine hour, the batches can differ in total amount of resources consumed in an operation. So it is necessary to use a work order for each batch to collect costs.

Exhibit 5-10 illustrates the physical flow and cost flow features of operation costing. The illustration is for two batches and three processes. Panel A illustrates the physical flows, and Panel B shows the cost flows. The letters *a* and *f* represent the assignment of direct materials cost to the two batches. This example assumes that all direct materials are issued at the very beginning. Thus, direct materials cost would be assigned to the

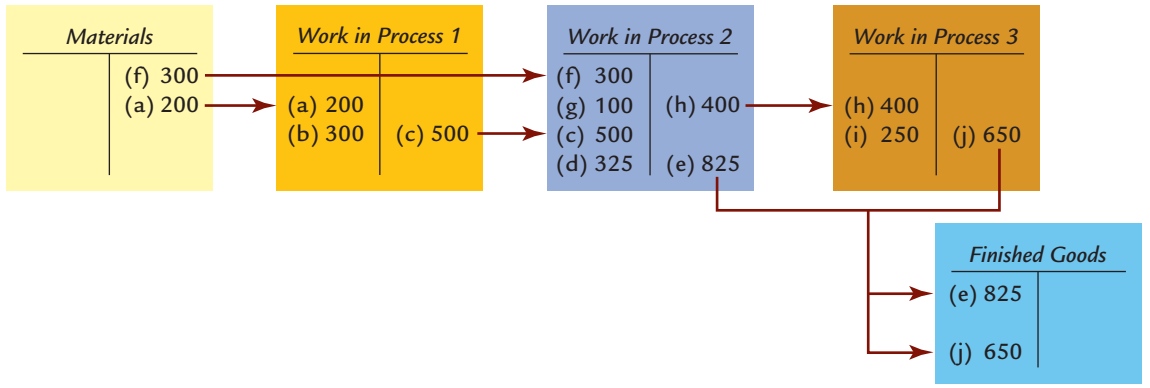
Exhibit 5-10

Basic Features of Operation Costing

Panel A: Physical Flows



Panel B: Cost Flows (shown by letter in Panel A and in dollars below)



work-in-process account for the beginning process for each batch. The example also illustrates that batches do not have to participate in every process. Batch A uses Processes 2 and 3, while Batch B uses Processes 1 and 2. The letters immediately following the process represent the application of conversion costs to the respective batches.

Operation Costing Example

To illustrate operation costing, consider the Gimli plant of Rite-Way Pharmaceuticals. The Gimli plant produces a variety of vitamin and mineral products. The company produces a multivitamin and mineral product as well as single vitamin and mineral

products—for example, bottles of vitamins C and E, calcium, and so on. Assume that the company also produces different strengths of vitamins (for example, 200 mg and 1,000 mg doses of vitamin C). The company also uses different sizes of bottles (for example, 60 and 120 capsules). There are four operations: blending, encapsulating, tableting, and bottling. Consider the following two work orders:

	Work Order 100	Work Order 101
Direct materials	Ascorbic acid	Vitamin E
	Capsules	Vitamin C
	Bottle (100 capsules)	Vitamin B-1
	Cap and labels	Vitamin B-2
		Vitamin B-4
		Vitamin B-12
		Biotin
		Zinc
		Bottle (60 tablets)
		Cap and labels
Operations	Blending	Blending
	Encapsulating	Tableting
	Bottling	Bottling
Number in batch	5,000 bottles	10,000 bottles

Notice how the work order specifies the direct materials needed, the operation required, and the size of the batch. Assume that the following costs are collected by work order:

	Work Order 100	Work Order 101
Direct materials	$4,000	$15,000
Conversion costs:		
Blending	1,000	3,000
Encapsulating	3,000	—
Tableting	—	4,000
Bottling	1,500	2,000
Total production costs	$9,500	$24,000

The journal entries associated with Work Order 100 are illustrated below. The first entry assumes that all materials needed for the batch are requisitioned at the start. Another possibility is to requisition the materials needed for the batch in each process as the batch enters that process.

1.	Work in Process—Blending	4,000	
	Materials		4,000
2.	Work in Process—Blending	1,000	
	Conversion Costs Applied		1,000
3.	Work in Process—Encapsulating	5,000	
	Work in Process—Blending		5,000
4.	Work in Process—Encapsulating	3,000	
	Conversion Costs Applied		3,000
5.	Work in Process—Bottling	8,000	
	Work in Process—Encapsulating		8,000
6.	Work in Process—Bottling	1,500	
	Conversion Costs Applied		1,500
7.	Finished Goods	9,500	
	Work in Process—Bottling		9,500

The journal entries for the other work order are not shown but would follow a similar pattern.

Summary of Learning Objectives

1. Describe the basic characteristics of process costing, including cost flows, journal entries, and the cost of production report.

- Process systems are characterized by a larger number of homogeneous products passing through a series of processes.
- Materials, labour, and overhead are applied in each process.
- Costs are accumulated by process and are transferred from one process to another by debiting the WIP of the receiving process and crediting the WIP of the transferring process.
- The production report summarizes manufacturing activity and costs for a process for a given period of time.

2. Describe process costing for settings without work-in-process inventories.

- No WIP inventories can occur in service organizations and JIT manufacturing firms.
- The unit cost is the costs of the period divided by the output of the period.

3. Describe process costing for situations with ending work-in-process inventories.

- With EWIP, output is measured using equivalent units.
- Equivalent units are the complete units that could have been produced given the total amount of effort expended.
- Five steps are followed to prepare a cost of production report:
  - Physical flow analysis
  - Equivalent unit calculation
  - Calculation of unit cost
  - Valuation of inventories
  - Cost reconciliation
- If materials are not added uniformly, multiple calculations of equivalent units are needed, one for each type of input.

4. Prepare a departmental production report using the FIFO method.

- The FIFO method excludes the equivalent output and costs in BWIP when the current-period unit cost is calculated.
- FIFO follows the process-costing principle.
- When calculating costs of goods transferred out, two categories of completed units are needed:
  - Units completed from BWIP
  - Units started and completed
- For the BWIP category, the cost is the sum of the prior-period cost and the current cost to complete the BWIP.

5. Prepare a departmental production report using the weighted average method.

- The weighted average method treats the equivalent output and costs in BWIP as if they belong to the current period when calculating unit cost.
- The costing of goods transferred out is simplified as there is only one category of completed units.

6. Prepare a departmental production report with transferred-in goods and changes in output measures.

- Partially completed goods (transferred-out goods) received from a prior department are transferred-in goods.

- For the receiving department, transferred-in goods are materials that are added at the beginning of the process.
- Transferred-in goods may need to be remeasured to reflect the output measure of the receiving department.

7. Describe the basic features of operation costing.

- Operation costing is a blend of job-order and process-costing procedures and can be used whenever batches of homogeneous products are produced.
- Job-order procedures are used to assign direct materials costs.
- Process procedures are used to assign conversion costs.

CORNERSTONES FOR CHAPTER 5

OBJECTIVE 8

Explain how spoilage is treated in a process-costing system.

Appendix: Spoiled Units

When spoilage takes place in a process-costing situation, its effects ripple through the cost of production report. Let's take Payson Company as an example. Payson Company produces a product that passes through two departments: Mixing and Cooking. In the Mixing Department, all direct materials are added at the beginning of the process. All other manufacturing inputs are added uniformly. The following information pertains to the Mixing Department for February:

a. Beginning work in process (BWIP), February 1: 100,000 kilograms, 40 percent complete with respect to conversion costs. The costs assigned to this work are as follows:

Direct materials	$20,000
Direct labour	10,000
Overhead	30,000

b. Ending work in process (EWIP), February 28: 50,000 kilograms, 60 percent complete with respect to conversion costs.

c. Units completed and transferred out: 360,000 kilograms. The following costs were added during the month:

Direct materials	$211,000
Direct labour	100,000
Overhead	270,000

d. All units are inspected at the 80 percent point of completion, and any spoiled units identified are discarded. During February, 10,000 kilograms were spoiled.

We can look at the five steps of the cost of production report. First, we must create a physical flow schedule.

Units to account for:	
Units, beginning work in process	100,000
Units started	320,000
Total units to account for	420,000
Units accounted for:	
Units transferred out	360,000
Units spoiled	10,000
Units, ending work in process	50,000
Total units accounted for	420,000

The second step is the creation of a schedule of equivalent units, shown below.

	Direct Materials	Conversion Costs
Units completed	360,000	360,000
Units spoiled × Percentage complete:		
Direct materials (10,000 × 100%)	10,000	
Conversion costs (10,000 × 80%)		8,000
Units in ending work in process × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	420,000	398,000

The cost per equivalent unit is as follows:

DM unit cost ($20,000 + $211,000)/420,000	$0.55
CC unit cost ($40,000 + $370,000)/398,000	1.03*
Total cost per equivalent unit	$1.58

*Rounded.

Now we must calculate the cost of goods transferred out and the cost of ending work in process. If the spoilage is normal (expected), the cost of spoiled units is added to the cost of the good units. In this case, the inspection occurred at the 80 percent point of completion. Therefore, none of the spoiled units are from ending work in process (as these units are only 60 percent complete and have not yet been inspected). Thus, all spoilage cost is assigned to the good units transferred out.

Cost of goods transferred out:	
Good units ($1.58 × 360,000)	$568,800
Spoiled units ($0.55 × 10,000) + ($1.03 × 8,000)	13,740
	$582,540

$$\text{Cost of ending work in process} = (\$0.55 \times 50{,}000) + (\$1.03 \times 30{,}000)$$
$$= \$58{,}400$$

Costs are reconciled as follows:

Costs to account for:	
Beginning work in process	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$582,540
Ending work in process	58,400
Total costs accounted for	$640,940*

*$60 difference is due to rounding.

Suppose that the spoilage was abnormal. Then the spoilage cost is assigned to a spoilage loss account. The costs are accounted for as follows:

$$\begin{aligned}\text{Cost of good units transferred out} &= \$1.58 \times 360{,}000 = \$568{,}800\\ \text{Spoiled units} &= (\$0.55 \times 10{,}000) + (\$1.03 \times 8{,}000)\\ &= \$13{,}740\\ \text{Cost of ending work in process} &= (\$0.55 \times 50{,}000) + (\$1.03 \times 30{,}000)\\ &= \$58{,}400\end{aligned}$$

Costs are reconciled as follows:

Costs to account for:	
Beginning work in process	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$568,800
Loss from abnormal spoilage	13,740
Ending work in process	58,400
Total costs accounted for	$640,940*

*$60 difference is due to rounding.

Notice the difference between the treatment of normal and abnormal spoilage. When spoilage is assumed to be normal, it is not tracked separately but is embedded in the total cost of good units. As a result, no one knows precisely how much spoilage adds to total manufacturing costs and whether an effort should be made to reduce it. The treatment of spoilage as abnormal is more in keeping with an emphasis on total quality management, where there is no tolerance allowed for waste. At least the product cost of spoiled goods is tracked in a separate account. Of course, a factory engaged in total quality management would not stop at classifying spoilage as abnormal. It would also identify the activities that are associated with these spoiled goods in an effort to discover the root causes of poor quality.

Review Problem

Weighted Average Method, Single Department; Equivalent Units, FIFO Method

Payson Company produces a product that passes through two departments: Mixing and Cooking. Both departments use the weighted average method. In the Mixing Department, all direct materials are added at the beginning of the process. All other manufacturing inputs are added uniformly. Payson uses the weighted average method. The following information pertains to the Mixing Department for February:

a. Beginning work in process (BWIP), February 1: 100,000 kilograms, 100 percent complete with respect to direct materials and 40 percent complete with respect to conversion costs. The costs assigned to this work are as follows:

Direct materials	$20,000
Direct labour	10,000
Overhead	30,000

b. Ending work in process (EWIP), February 28: 50,000 kilograms, 100 percent complete with respect to direct materials and 60 percent complete with respect to conversion costs.

c. Units completed and transferred out: 370,000 kilograms. The following costs were added during the month:

Direct materials	$211,000
Direct labour	100,000
Overhead	270,000

Required:

1. Prepare a physical flow schedule.
2. Prepare a schedule of equivalent units.
3. Compute the cost per equivalent unit.
4. Compute the cost of goods transferred out and the cost of ending work in process.
5. Prepare a cost reconciliation.
6. Repeat Requirements 2–4 using the FIFO method.

Solution:

1. Physical flow schedule:

Units to account for:		
Units, BWIP		100,000
Units started		320,000
Total units to account for		420,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	270,000	
From BWIP	100,000	370,000
Units, EWIP		50,000
Total units accounted for		420,000

2. Schedule of equivalent units:

	Direct Materials	Conversion Costs
Units completed	370,000	370,000
Units, EWIP × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	420,000	400,000

3. Cost per equivalent unit:

DM unit cost ($20,000 + $211,000)/420,000	$0.550
CC unit cost ($40,000 + $370,000)/400,000	1.025
Total cost per equivalent unit	$1.575

4. Cost of goods transferred out and cost of ending work in process:

$$\text{Cost of goods transferred out} = \$1.575 \times 370{,}000 = \$582{,}750$$
$$\text{Cost of EWIP} = (\$0.55 \times 50{,}000) + (\$1.025 \times 30{,}000) = \$58{,}250$$

5. Cost reconciliation:

Costs to account for:	
BWIP	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$582,750
EWIP	58,250
Total costs accounted for	$641,000

6. FIFO results:

Schedule of equivalent units:

	Direct Materials	Conversion Costs
Units started and completed	270,000	270,000
Units, BWIP × Percentage to complete:	—	60,000
Units, EWIP × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	320,000	360,000

Cost per equivalent unit:	
DM unit cost ($211,000/320,000)	$0.659*
CC unit cost ($370,000/360,000)	1.028*
Total cost per equivalent unit	$1.687

*Rounded.

Cost of goods transferred out and cost of ending work in process:

$$\text{Cost of goods transferred out} = (\$1.687 \times 270{,}000) + (\$1.028 \times 60{,}000) + \$60{,}000$$
$$= \$577{,}170^{*}$$
$$\text{Cost of EWIP} = (\$0.659 \times 50{,}000) + (\$1.028 \times 30{,}000) = \$63{,}790^{*}$$

*Difference of $40 in total costs due to rounding

Key Terms

Batch production processes, 231
Cost reconciliation, 212
Equivalent units of output, 211
FIFO costing method, 216
Operation costing, 232
Physical flow schedule, 212
Process, 204
Process-costing principle, 210
Production report, 208
Transferred-in cost, 205
Weighted average costing method, 222
Work orders, 232

Discussion Questions

1. What is a process? Provide an example that illustrates the definition.
2. Describe the differences between process costing and job-order costing.
3. What journal entry would be made as goods are transferred out from one department to another department? From the final department to the warehouse?
4. What are transferred-in costs?
5. Explain why transferred-in costs are a special type of material for the receiving department.
6. What is a production report? What purpose does this report serve?
7. Can process costing be used for a service organization? Explain. Describe how process costing can be used for JIT manufacturing firms.
8. What are equivalent units? Why are they needed in a process-costing system?
9. How is the equivalent unit calculation affected when direct materials are added at the beginning or end of the process rather than uniformly throughout the process?
10. Describe the five steps in accounting for the manufacturing activity of a processing department, and indicate how they interrelate.
11. Under the weighted average method, how are prior-period costs and output treated? How are they treated under the FIFO method?
12. Under what conditions will the weighted average and FIFO methods give essentially the same results?
13. In assigning costs to goods transferred out, how do the weighted average and FIFO methods differ?
14. How are transferred-in costs treated in the calculation of equivalent units?
15. What is operation costing? When is it used?

Cornerstone Exercises

Cornerstone Exercise 5-1 COST FLOWS

OBJECTIVE 1
CORNERSTONE 5-1

Beauchemin Company produced 50,000 metal components for tractors. There were no beginning or ending work-in-process inventories in any department. Beauchemin incurred the following costs for October:

	Moulding Department	Grinding Department	Finishing Department
Direct materials	$6,500	$2,600	$4,000
Direct labour	5,000	4,400	6,000
Applied overhead	8,500	7,000	5,500

Required:

1. Calculate the costs transferred out of each department.
2. Prepare the journal entries corresponding to these transfers. Also, prepare the journal entry for Grinding that reflects the costs added to the transferred-in goods received from Moulding.
3. What if the Grinding Department had an ending WIP of $6,000? Calculate the cost transferred out and provide the journal entry that would reflect this transfer. What is the effect on finished goods calculated in Requirement 1, assuming the other two departments have no ending WIP?

Cornerstone Exercise 5-2 UNIT COST, NO WORK-IN-PROCESS INVENTORIES

OBJECTIVE 2
CORNERSTONE 5-2
SERVICE

Goldman Dentistry has a hygienist that performs cleanings for its patients. During May, Goldman had the following cost and output information:

Direct materials	$800
Hygienist's salary	$4,450
Overhead	$6,750
Number of cleanings	600

Required:

1. Calculate the cost per cleaning for May.
2. Calculate the cost of services sold for May.
3. What if Goldman found a way to reduce overhead costs by 40 percent? How would this affect the profit per cleaning?

OBJECTIVE 3

CORNERSTONE 5-3

SERVICE

Cornerstone Exercise 5-3 PHYSICAL FLOW AND EQUIVALENT UNITS WITH EWIP

Fleming, Fleming, and Chan, a local CA firm, provided the following data for individual tax returns processed for March (output is measured in number of returns):

Units, beginning work in process	—
Units started	6,000
Units completed	5,000
Units, ending work in process (50% complete)	1,000
Total production costs	$5,500

Required:

1. Prepare a physical flow schedule
2. Prepare an equivalent units schedule. Explain why output is measured in equivalent units.
3. ***What if*** EWIP is 80 percent complete? How would this change affect the physical flow schedule? The equivalent units schedule?

OBJECTIVE 3

CORNERSTONE 5-4

SERVICE

Cornerstone Exercise 5-4 COST INFORMATION

During June, Herring Associates incurred total production costs of $40,000 for copy editing manuscripts and had the following equivalent units schedule:

Units completed	190
Units in EWIP × Fraction complete:	
25 × 0.40	10
Equivalent units	200

Required:

1. Calculate the cost of copy editing one manuscript for June.
2. Assign costs to manuscripts completed and to EWIP and then do a cost reconciliation.
3. ***What if*** the costs assigned to manuscripts completed and EWIP were calculated using a unit cost of $250? What is the discrepancy between the costs assigned and the costs to account for? What could have caused an incorrect unit cost?

OBJECTIVE 3

CORNERSTONE 5-5

Cornerstone Exercise 5-5 PRODUCTION REPORT

Edge Company produces power drinks. The Mixing Department, the first process department, mixes the ingredients required for the drinks. The following data are for April:

Work in process, April 1	—
Litres started	30,000
Litres transferred out	25,000
Litres in EWIP	5,000
Direct materials cost	$28,000
Direct labour cost	$56,000
Overhead applied	$112,000

Direct materials are added at the beginning of the process. Ending inventory is 60 percent complete with respect to direct labour and overhead.

Required:

1. Why would a manager want a production report?
2. Prepare a production report for the Mixing Department for April.

Cornerstone Exercise 5-6 NONUNIFORM INPUTS

OBJECTIVE 3
CORNERSTONE 5-6

Dulce Company produces premium chocolate candy bars. Conversion costs are added uniformly. For March, EWIP is 40 percent complete with respect to conversion costs. The following information is provided for March:

Physical flow schedule:

Units to account for:		
Units in BWIP		0
Units started		50,000
Total units to account for		50,000
Units accounted for:		
Units completed:		
From BWIP	0	
Started and completed	40,000	40,000
Units in EWIP		10,000
Total units accounted for		50,000

Inputs	
Direct Materials	Conversion Costs
$25,000	$44,000

Required:

1. Calculate the equivalent units for each input category.
2. Calculate the unit cost for each category and in total.
3. ***What if*** a different type of material is *also* added at the end of the process (a candy wrapper), costing $4,000? Calculate the new unit cost.

Cornerstone Exercise 5-7 UNIT INFORMATION WITH BWIP, FIFO METHOD

OBJECTIVE 4
CORNERSTONE 5-7

Fedoruk Products produces a barbeque sauce using three departments: Cooking, Mixing, and Bottling. In the Cooking Department, all materials are added at the *beginning* of the process. Output is measured in 100-gram units. The production data for July are as follows:

Production:	
Units in process, July 1, 60% complete*	10,000
Units completed and transferred out	80,000
Units in process, July 31, 80% complete*	15,000

*With respect to conversion costs.

Required:

1. Prepare a physical flow schedule for July.
2. Prepare an equivalent units schedule for July using the FIFO method.
3. ***What if*** 60 percent of the materials were added at the beginning of the process and 40 percent were added at the end of the process (all ingredients used are treated as the same type or category of materials)? How many equivalent units of materials would there be?

Cornerstone Exercise 5-8 COST INFORMATION AND FIFO

OBJECTIVE 4
CORNERSTONE 5-8

Hassan Company had the equivalent units schedule and cost information for its Sewing Department for the month of December shown below.

Required:

1. Calculate the unit cost for December, using the FIFO method.
2. Calculate the cost of goods transferred out, calculate the cost of EWIP, and reconcile the costs assigned with the costs to account for.
3. ***What if*** you were asked for the unit cost from the month of November? Calculate November's unit cost and explain why this might be of interest to management.

	Direct Materials	Conversion Costs
Units started and completed	40,000	40,000
Add: Units in beginning work in process ×		
Percentage to complete:		
5,000 × 0% direct materials	—	—
5,000 × 50% conversion costs	—	2,500
Add: Units in ending work in process ×		
Percentage complete:		
10,000 × 100% direct materials	10,000	—
10,000 × 35% conversion costs	—	3,500
Equivalent units of output	50,000	46,000
Costs:		
Work in process, December 1:		
Direct materials		$ 35,000
Conversion costs		10,000
Total work in process		$ 45,000
Current costs:		
Direct materials		$400,000
Conversion costs		184,000
Total current costs		$584,000

OBJECTIVE 5

CORNERSTONE 5-9

Cornerstone Exercise 5-9 UNIT INFORMATION WITH BWIP, WEIGHTED AVERAGE METHOD

Fedoruk Products produces a barbeque sauce using three departments: Cooking, Mixing, and Bottling. In the Cooking Department, all materials are added at the *beginning* of the process. Output is measured in 100-gram units. The production data for July are as follows:

Production:	
Units in process, July 1, 60% complete*	10,000
Units completed and transferred out	80,000
Units in process, July 31, 80% complete*	15,000

*With respect to conversion costs.

Required:

1. Prepare a physical flow schedule for July.
2. Prepare an equivalent units schedule for July using the weighted average method.
3. ***What if*** you were asked to calculate the FIFO equivalent units beginning with the weighted average equivalent units? Calculate the FIFO equivalent units by subtracting out the prior-period output found in BWIP.

OBJECTIVE 5

CORNERSTONE 5-10

Cornerstone Exercise 5-10 COST INFORMATION AND THE WEIGHTED AVERAGE METHOD

Morrison Company had the equivalent units schedule and cost information for its Sewing Department for the month of December shown below.

Required:

1. Calculate the unit cost for December, using the weighted average method.
2. Calculate the cost of goods transferred out, calculate the cost of EWIP, and reconcile the costs assigned with the costs to account for.
3. ***What if*** you were asked to show that the weighted average unit cost for materials is the blend of the November unit materials cost and the December unit materials cost? The November unit materials cost is $6.60 ($66,000/10,000), and the December unit materials cost is $12.22 ($550,000/45,000). The equivalent units in BWIP are 10,000, and the FIFO equivalent units are 45,000. Calculate the weighted average unit materials cost using weights defined as the proportion of total units completed from each source (BWIP output and current output).

	Direct Materials	Conversion Costs
Units completed	45,000	45,000
Add: Units in ending work in process × Percentage complete:		
10,000 × 100% direct materials	10,000	—
10,000 × 45% conversion costs	—	4,500
Equivalent units of output	55,000	49,500
Costs:		
Work in process, December 1:		
Direct materials		$ 66,000
Conversion costs		14,000
Total work in process		$ 80,000
Current costs:		
Direct materials		$550,000
Conversion costs		184,000
Total current costs		$734,000

Exercises

Exercise 5-11 JOURNAL ENTRIES

OBJECTIVE 1 2

K-Briggs Company has three process departments: Mixing, Encapsulating, and Bottling. At the beginning of the year, there were no work-in-process or finished goods inventories. The following data are available for the month of July:

Department	Manufacturing Costs Added*	Ending Work in Process
Mixing	$216,000	$54,000
Encapsulating	198,000	45,000
Bottling	180,000	9,000

*Includes only the direct materials, direct labour, and the overhead used to process the partially finished goods received from the prior department. The transferred-in cost is not included.

Required:

1. Prepare journal entries that show the transfer of costs from one department to the next (including the entry to transfer the costs of the final department).
2. Prepare T-accounts for the entries made in Requirement 1. Use arrows to show the flow of costs.

Exercise 5-12 PROCESS COSTING, SERVICE ORGANIZATION

OBJECTIVE 2

SERVICE

A local barbershop cuts the hair of 1,000 customers per month. The clients are men, and the barbers offer no special styling. During the month of March, 1,000 customers were serviced. The cost of haircuts includes the following:

Direct labour	$ 7,000
Direct materials	1,000
Overhead	2,000
Total	$10,000

Required:

1. Explain why process costing is appropriate for this haircutting operation.
2. Calculate the cost per haircut.
3. Can you identify some possible direct materials used for this haircutting service? Is the usage of direct materials typical of services? If so, provide examples of services that use direct materials. Can you think of some services that would not use direct materials?

OBJECTIVE 1 2

Exercise 5-13 JIT MANUFACTURING AND PROCESS COSTING

Romano Company uses JIT manufacturing. There are several manufacturing cells set up within one of its factories. One of the cells makes stands for flat-screen televisons. The cost of production for the month of April is given below.

Cell labour	$ 40,000
Direct materials	100,000
Overhead	80,000
Total	$220,000

During May, 20,000 stands were produced and sold.

Required:

1. Explain why process costing can be used for computing the cost of production for the stands.
2. Calculate the cost per unit for a stand.
3. Explain how activity-based costing can be used to determine the overhead assigned to the cell.

OBJECTIVE 2 3

Exercise 5-14 PHYSICAL FLOW, EQUIVALENT UNITS, UNIT COSTS, NO BEGINNING WIP INVENTORY, ACTIVITY-BASED COSTING

Arnez Inc. produces a subassembly used in the production of hydraulic cylinders. The subassemblies are produced in three departments: Plate Cutting, Rod Cutting, and Welding. Overhead is applied using the following drivers and activity rates:

Driver	Rate	Actual Usage (by Plate Cutting)
Direct labour cost	75% of direct labour	$732,000
Inspection hours	$20 per hour	7,450 hours
Purchase orders	$500 per order	800 orders

Other data for the Plate Cutting Department are as follows:

Beginning work in process	—
Units started	740,000
Direct materials cost	$3,700,000
Units, ending work in process (100% materials; 80% conversion)	40,000

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for:
   a. Direct materials
   b. Conversion costs
3. Calculate unit costs for:
   a. Direct materials
   b. Conversion costs
   c. Total manufacturing
4. Provide the following information:
   a. The total cost of units transferred out
   b. The journal entry for transferring costs from Plate Cutting to Welding
   c. The cost assigned to units in ending inventory

OBJECTIVE 1 3

Exercise 5-15 PRODUCTION REPORT, NO BEGINNING INVENTORY

Piel Suave Company manufactures sun protection lotion. The Mixing Department, the first process department, mixes the chemicals required for the lotion. The following data are for 2013:

Work in process, January 1, 2013	—
Units started	900,000
Units transferred out	756,000
Direct materials cost	$900,000
Direct labour cost	$1,785,600
Overhead applied	$2,678,400

Direct materials are added at the beginning of the process. Ending inventory is 95 percent complete with respect to direct labour and overhead.

Required:

Prepare a production report for the Mixing Department for 2013.

Exercise 5-16 WEIGHTED AVERAGE METHOD, FIFO METHOD, PHYSICAL FLOW, EQUIVALENT UNITS

OBJECTIVE 3 4 5

Darim Company manufactures a product that passes through two processes: Fabrication and Assembly. The following information was obtained for the Fabrication Department for June:

a. All materials are added at the beginning of the process.
b. Beginning work in process had 60,000 units, 30 percent complete with respect to conversion costs.
c. Ending work in process had 12,000 units, 25 percent complete with respect to conversion costs.
d. Started in process, 75,000 units.

Required:

1. Prepare a physical flow schedule.
2. Compute equivalent units using the weighted average method.
3. Compute equivalent units using the FIFO method.

Exercise 5-17 FIFO METHOD, VALUATION OF GOODS TRANSFERRED OUT AND ENDING WORK IN PROCESS

OBJECTIVE 4

Alden Company uses the FIFO method to account for the costs of production. For Crushing, the first processing department, the following equivalent units schedule has been prepared:

	Direct Materials	Conversion Costs
Units started and completed	22,000	22,000
Units, beginning work in process:		
10,000 × 0%	—	—
10,000 × 40%	—	4,000
Units, ending work in process:		
6,000 × 100%	6,000	—
6,000 × 75%	—	4,500
Equivalent units of output	28,000	30,500

The cost per equivalent unit for the period was as follows:

Direct materials	$3.00
Conversion costs	5.00
Total	$8.00

The cost of beginning work in process was direct materials, $30,000; conversion costs, $25,000.

Required:

1. Determine the cost of ending work in process and the cost of goods transferred out.
2. Prepare a physical flow schedule.

OBJECTIVE 5

Exercise 5-18 EQUIVALENT UNITS—WEIGHTED AVERAGE METHOD

The following data are for four independent process-costing departments. Inputs are added continuously.

	A	B	C	D
Beginning inventory	3,000	2,000	—	25,000
Percent completion	30%	75%	—	60%
Units started	19,000	20,000	48,000	35,000
Ending inventory	4,000	—	8,000	10,000
Percent completion	20%	—	25%	10%

Required:

Compute the equivalent units of production for each of the preceding departments using the weighted average method.

OBJECTIVE 4

Exercise 5-19 EQUIVALENT UNITS, FIFO METHOD

Using the data from **Exercise 5-18**, compute the equivalent units of production for each of the four departments using the FIFO method.

OBJECTIVE 5

Exercise 5-20 WEIGHTED AVERAGE METHOD, UNIT COST, VALUATION OF GOODS TRANSFERRED OUT AND ENDING WORK IN PROCESS

Safir Products Inc. produces plastic cases used for video cameras. The product passes through three departments. For May, the following equivalent units schedule was prepared for the first department:

	Direct Materials	Conversion Costs
Units completed	5,000	5,000
Units, ending work in process		
× Percentage complete:		
6,000 × 100%	6,000	—
6,000 × 50%	—	3,000
Equivalent units of output	11,000	8,000

Costs assigned to beginning work in process: direct materials, $30,000; conversion costs, $5,000. Manufacturing costs incurred during May: direct materials, $25,000; conversion costs, $65,000. Safir uses the weighted average method.

Required:

1. Compute the unit cost for May.
2. Determine the cost of ending work in process and the cost of goods transferred out.

OBJECTIVE 4

Exercise 5-21 FIFO METHOD, UNIT COST, VALUATION OF GOODS TRANSFERRED OUT AND ENDING WORK IN PROCESS

Rae Company produces women's blouses and uses the FIFO method to account for its manufacturing costs. The product Rae makes passes through two processes: Cutting and Sewing. During April, Rae's controller prepared the following equivalent units schedule for the Cutting Department:

	Direct Materials	Conversion Costs
Units started and completed	40,000	40,000
Units, beginning work in process:		
10,000 × 0%	—	—
10,000 × 50%	—	5,000
Units, ending work in process:		
20,000 × 100%	20,000	—
20,000 × 25%	—	5,000
Equivalent units of output	60,000	50,000

Costs in beginning work in process were direct materials, $20,000; conversion costs, $80,000. Manufacturing costs incurred during April were direct materials, $240,000; conversion costs, $320,000.

Required:

1. Prepare a physical flow schedule for April.
2. Compute the cost per equivalent unit for April.
3. Determine the cost of ending work in process and the cost of goods transferred out.
4. Prepare the journal entry that transfers the costs from Cutting to Sewing.

Exercise 5-22 WEIGHTED AVERAGE METHOD, EQUIVALENT UNITS, UNIT COST, MULTIPLE DEPARTMENTS

OBJECTIVE 5 6

Layton Company has a product that passes through two processes: Grinding and Polishing. During December, the Grinding Department transferred 20,000 units to the Polishing Department. The cost of the units transferred into the second department was $40,000. Direct materials are added uniformly in the second process. Units are measured the same way in both departments.

The second department (Polishing) had the following physical flow schedule for December:

Units to account for:	
Units, beginning work in process	4,000 (40% complete)
Units started	?
Total units to account for	?
Units accounted for:	
Units, ending work in process	8,000 (50% complete)
Units completed	?
Units accounted for	?

Costs in beginning work in process for the Polishing Department were direct materials, $5,000; conversion costs, $6,000; and transferred in, $8,000. Costs added during the month: direct materials, $32,000; conversion costs, $50,000; and transferred in, $40,000.

Required:

1. Assuming the use of the weighted average method, prepare a schedule of equivalent units.
2. Compute the unit cost for the month.

Exercise 5-23 FIFO METHOD, EQUIVALENT UNITS, UNIT COST, MULTIPLE DEPARTMENTS

OBJECTIVE 4 6

Using the same data found in **Exercise 5-22**, assume the company uses the FIFO method.

Required:

Prepare a schedule of equivalent units, and compute the unit cost for the month of December.

Exercise 5-24 JOURNAL ENTRIES, COST OF ENDING INVENTORIES

OBJECTIVE 1 3

Baxter Company has two processing departments: Assembly and Finishing. A predetermined overhead rate of $10 per DLH is used to assign overhead to production. The company experienced the following operating activity for April:

a. Materials issued to Assembly, $24,000
b. Direct labour cost: Assembly, 500 hours at $9.20 per hour; Finishing, 400 hours at $8 per hour
c. Overhead applied to production
d. Goods transferred to Finishing, $32,500
e. Goods transferred to finished goods warehouse, $20,500
f. Actual overhead incurred, $10,000

Required:

1. Prepare the required journal entries for the preceding transactions.
2. Assuming Assembly and Finishing have no beginning work-in-process inventories, determine the cost of each department's ending work-in-process inventories.

OBJECTIVE 7

Exercise 5-25 OPERATION COSTING: BREAD MANUFACTURING

Tasty Bread makes and supplies bread throughout the Prairie provinces. Three types of bread are produced: loaves, rolls, and buns. Seven operations describe the production process.

a. Mixing: Flour, milk, yeast, salt, butter, and so on, are mixed in a large vat.
b. Shaping: A conveyor belt transfers the dough to a machine that weighs it and shapes it into loaves, rolls, or buns, depending on the type being produced.
c. Rising: The individually shaped dough is allowed to sit and rise.
d. Baking: The dough is moved to a 30-metre-long funnel oven. (The dough enters the oven on racks and spends 20 minutes moving slowly through the oven.)
e. Cooling: The bread is removed from the oven and allowed to cool.
f. Slicing: For loaves and buns (hamburger and hot dog), the bread is sliced.
g. Packaging: The bread is wrapped (packaged).

Tasty produces its products in batches. The size of the batch depends on the individual orders that must be filled (orders come from retail grocers throughout the provinces). Usually, as soon as one batch is mixed, a second batch begins the mixing operation.

Required:

1. Identify the conditions that must be present for operation costing to be used in this setting. If these conditions are not met, explain how process costing would be used. If process costing is used, would you recommend the weighted average method or the FIFO method? Explain.
2. Assume that operation costing is the best approach for this bread manufacturer. Describe in detail how you would use operation costing. Use a batch of dinner rolls (consisting of 1,000 packages of 12 rolls) and a batch of whole wheat loaves (consisting of 5,000, 500-gram sliced loaves) as examples.

Problems

OBJECTIVE 3 5

Problem 5-26 WEIGHTED AVERAGE METHOD, PHYSICAL FLOW, EQUIVALENT UNITS, UNIT COSTS, COST ASSIGNMENT, ABC

Harper Fabrication Inc. manufactures frames for bicycles. Each frame passes through three processes: Cutting, Welding, and Painting. In September, the Cutting Department of the Courtenay, B.C., plant reported the following data:

a. In Cutting, all direct materials are added at the beginning of the process.
b. Beginning work in process consisted of 40,500 units, 20 percent complete with respect to direct labour and overhead. Costs in beginning inventory included direct materials, $1,215,000; direct labour, $222,600; and applied overhead, $150,000.
c. Costs added to production during the month were direct materials, $2,565,000; direct labour, $3,471,150. Overhead was assigned using the following information:

Activity	Rate	Actual Driver Usage
Inspection	$150 per inspection hour	4,000 inspection hours
Maintenance	$750 per maintenance hour	1,600 maintenance hours
Receiving	$300 per receiving order	2,000 receiving orders

d. At the end of the month, 121,500 units were transferred out to Welding, leaving 13,500 units in ending work in process, 25 percent complete.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for direct materials and conversion costs.
3. Compute unit cost under weighted average.
4. Calculate the cost of goods transferred to Welding at the end of the month. Calculate the cost of ending inventory.
5. Prepare the journal entry that transfers the goods from Cutting to Welding.

Problem 5-27 FIFO METHOD, PHYSICAL FLOW, EQUIVALENT UNITS, UNIT COSTS, COST ASSIGNMENT

OBJECTIVE 3 4

Refer to the data in **Problem 5-26**. Assume that the FIFO method is used.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for direct materials and conversion costs.
3. Compute unit cost. Round to three decimal places.
4. Calculate the cost of goods transferred to Welding at the end of the month. Calculate the cost of ending inventory.

Problem 5-28 WEIGHTED AVERAGE METHOD, SINGLE DEPARTMENT ANALYSIS, UNIFORM COSTS

OBJECTIVE 5

Lafleur Company produces a product that passes through three processes: Fabrication, Assembly, and Finishing. All manufacturing costs are added uniformly for all processes. The following information was obtained for the Fabrication Department for June 2013:

a. Work in process, June 1, had 30,000 units (40 percent completed) and the following costs:

Direct materials	$24,000
Direct labour	36,000
Overhead	12,000

b. During the month of June, 60,000 units were completed and transferred to the Assembly Department, and the following costs were added to production:

Direct materials	$72,000
Direct labour	48,000
Overhead	54,000

c. On June 30, there were 15,000 partially completed units in process. These units were 80 percent complete.

Required:

Prepare a cost of production report for the Fabrication Department for June using the weighted average method of costing. The report should disclose the physical flow of units, equivalent units, and unit costs and should track the disposition of manufacturing costs.

Problem 5-29 FIFO METHOD, SINGLE DEPARTMENT ANALYSIS, ONE COST CATEGORY

OBJECTIVE 4

Refer to the data in **Problem 5-28**.

Required:

Prepare a cost of production report for the Fabrication Department for June using the FIFO method of costing.

Problem 5-30 SERVICE ORGANIZATION WITH WORK-IN-PROCESS INVENTORIES, MULTIPLE DEPARTMENTS, FIFO METHOD, UNIT COST

OBJECTIVE 3 4 6

SERVICE

Akbar Credit Corporation is a wholly owned subsidiary of a large manufacturer of computers. Akbar is in the business of financing computers, software, and other services that the parent corporation sells. Akbar has two departments that are involved in financing services: the Credit Department and the Business Practices Department. The Credit Department receives requests for financing from field sales representatives, records customer information on a preprinted form, and then enters the information into the computer system to check the creditworthiness of the customer. (Other actions may be taken if the customer is not in the database.) Once creditworthiness information is known, a printout is produced with this information plus other customer-specific information. The completed form is transferred to the Business Practices Department.

The Business Practices Department modifies the standard loan covenant as needed (in response to customer request or customer risk profile). When this activity is completed, the loan is priced. This is done by keying information from the partially processed form into a personal computer spreadsheet program. The program provides a

recommended interest rate for the loan. Finally, a form specifying the loan terms is attached to the transferred-in document. A copy of the loan-term form is sent to the sales representative and serves as the quote letter.

The following cost and service activity data for the Business Practices Department are provided for the month of May:

Transferred-in applications	11,200
Applications in process, May 1, 40% complete*	2,000
Applications in process, May 31, 25% complete*	3,200

*All materials and supplies are used at the end of the process.

	Transferred In	Direct Materials	Conversion Costs
Costs:			
Beginning work in process	$ 18,000	—	$ 11,200
Costs added	112,000	$5,000	150,000

Required:

1. How would you define the output of the Business Practices Department?
2. Using the FIFO method, prepare the following for the Business Practices Department:
   a. A physical flow schedule
   b. An equivalent units schedule
   c. Calculation of unit costs
   d. Cost of ending work in process and cost of units transferred out
   e. A cost reconciliation

OBJECTIVE ➤ 1 5 6

Problem 5-31 WEIGHTED AVERAGE METHOD, JOURNAL ENTRIES

Muskoka Company uses a process-costing system. The company manufactures a product that is processed in two departments: Moulding and Assembly. In the Moulding Department, direct materials are added at the beginning of the process; in the Assembly Department, additional direct materials are added at the end of the process. In both departments, conversion costs are incurred uniformly throughout the process. As work is completed, it is transferred out. The following table summarizes the production activity and costs for February:

	Moulding	Assembly
Beginning inventories:		
Physical units	10,000	8,000
Costs:		
Transferred in	—	$45,200
Direct materials	$22,000	—
Conversion costs	$13,800	$16,800
Current production:		
Units started	25,000	?
Units transferred out	30,000	35,000
Costs:		
Transferred in	—	?
Direct materials	$56,250	$39,550
Conversion costs	$103,500	$136,500
Percentage of completion:		
Beginning inventory	40%	50%
Ending inventory	80	50

Required:

1. Using the weighted average method, prepare the following for the Moulding Department:
   a. A physical flow schedule
   b. An equivalent units calculation
   c. Calculation of unit costs. Round to four decimal places.

d. Cost of ending work in process and cost of goods transferred out
e. A cost reconciliation

2. Prepare journal entries that show the flow of manufacturing costs for the Moulding Department. Materials are added at the beginning of the process.
3. Repeat Requirements 1 and 2 for the Assembly Department.

Problem 5-32 FIFO METHOD, TWO-DEPARTMENT ANALYSIS

OBJECTIVE 2 4 6

Refer to the data in **Problem 5-31**.

Required:

Repeat the requirements in **Problem 5-31** using the FIFO method.

Problem 5-33 WEIGHTED AVERAGE METHOD, TWO-DEPARTMENT ANALYSIS, CHANGE IN OUTPUT MEASURE

OBJECTIVE 5 6

Healthway uses a process-costing system to compute the unit costs of the minerals that it produces. It has three departments: Mixing, Tableting, and Bottling. In Mixing, the ingredients for the minerals are measured, sifted, and blended together. The mix is transferred out in litre containers. The Tableting Department takes the powdered mix and places it in capsules. One litre of powdered mix converts to 1,600 capsules. After the capsules are filled and polished, they are transferred to Bottling where they are placed in bottles, which are then affixed with a safety seal and a lid and labelled. Each bottle receives 50 capsules.

During July, the following results are available for the first two departments (direct materials are added at the beginning in both departments):

	Mixing	Tableting
Beginning inventories:		
Physical units	5 litres	4,000 capsules
Costs:		
Direct materials	$120	$32
Direct labour	128	20
Overhead	?	?
Transferred in	—	140
Current production:		
Transferred out	125 litres	198,000 capsules
Ending inventory	6 litres	6,000 capsules
Costs:		
Direct materials	$3,144	$1,584
Transferred in	—	?
Direct labour	4,096	1,944
Overhead	?	?
Percentage of completion:		
Beginning inventory	40%	50%
Ending inventory	50	40

Overhead in both departments is applied as a percentage of direct labour costs. In the Mixing Department, overhead is 200 percent of direct labour. In the Tableting Department, the overhead rate is 150 percent of direct labour.

Required:

1. Prepare a production report for the Mixing Department using the weighted average method. Follow the five steps outlined in the chapter. Round unit cost to three decimal places.
2. Prepare a production report for the Tableting Department. Materials are added at the beginning of the process. Follow the five steps outlined in the chapter. Round unit cost to four decimal places.

Problem 5-34 FIFO METHOD, TWO-DEPARTMENT ANALYSIS

OBJECTIVE 4 6

Refer to the data in **Problem 5-33**.

Required:

Prepare a production report for each department using the FIFO method.

OBJECTIVE 7

Problem 5-35 OPERATION COSTING: UNIT COSTS AND JOURNAL ENTRIES

Burrows Company produces two brands of a popular pain medication: regular strength and extra strength. Regular strength is produced in tablet form, and extra strength is produced in capsule form. All direct materials needed for each batch are requisitioned at the start. The work orders for two batches of the products are shown below, along with some associated cost information:

	Work Order 121 (Regular Strength)	Work Order 122 (Extra Strength)
Direct materials (actual costs):	$9,000	$15,000
Applied conversion costs:		
Mixing	?	?
Tableting	$5,000	—
Encapsulating	—	$6,000
Bottling	?	?
Batch size (bottles of 100 units)	12,000	18,000

In the Mixing Department, conversion costs are applied on the basis of direct labour hours. Budgeted conversion costs for the department for the year were $60,000 for direct labour and $190,000 for overhead. Budgeted direct labour hours were 5,000. It takes one minute of labour time to mix the ingredients needed for a 100-unit bottle (for either product).

In the Bottling Department, conversion costs are applied on the basis of machine hours. Budgeted conversion costs for the department for the year were $400,000. Budgeted machine hours were 20,000. It takes one-half minute of machine time to fill a bottle of 100 units.

Required:

1. What are the conversion costs applied in the Mixing Department for each batch? The Bottling Department?
2. Calculate the cost per bottle for the regular and extra strength pain medications.
3. Prepare the journal entries that record the costs of the 12,000 regular strength batch as it moves through the various operations.
4. Suppose that the direct materials are requisitioned by each department as needed for a batch. For the 12,000 regular strength batch, direct materials are requisitioned for the Mixing and Bottling departments. Assume that the amount of cost is split evenly between the two departments. How will this change the journal entries made in Requirement 3?

OBJECTIVE 3 5 7

Problem 5-36 CASE ON PROCESS COSTING, OPERATION COSTING, IMPACT ON RESOURCE ALLOCATION DECISION

Ruiz Manufacturing, a division of Farnsworth Sporting Inc. produces two different models of bows and eight models of knives. The bow-manufacturing process involves the production of two major subassemblies: the limbs and the handle. The limbs pass through four sequential processes before reaching final assembly: lay-up, moulding, fabricating, and finishing. In the Lay-Up Department, limbs are created by laminating layers of wood. In Moulding, the limbs are heat treated, under pressure, to form a strong, resilient limb. In the Fabricating Department, any protruding glue or other processing residue is removed. Finally, in Finishing, the limbs are cleaned with acetone, dried, and sprayed with the final finishes.

The handles pass through two processes before reaching final assembly: pattern and finishing. In the Pattern Department, blocks of wood are fed into a machine that is set to shape the handles. Different patterns are possible, depending on the machine's setting. After coming out of the machine, the handles are cleaned and smoothed. They then pass to the Finishing Department, where they are sprayed with the final finishes. In Final Assembly, the limbs and handles are assembled into different models using purchased parts such as pulley assemblies, weight adjustment bolts, side plates, and string.

Ruiz, since its inception, has been using process costing to assign product costs. A predetermined overhead rate is used based on direct labour dollars (80 percent of direct labour dollars). Recently, Ruiz has hired a new controller, Karen Jenkins. After reviewing the product costing procedures, Karen requested a meeting with the divisional manager, Aaron Suhr. The following is a transcript of their conversation:

KAREN: Aaron, I have some concerns about our cost accounting system. We make two different models of bows and are treating them as if they were the same product. Now I

know that the only real difference between the models is the handle. The processing of the handles is the same, but the handles differ significantly in the amount and quality of wood used. Our current costing does not reflect this difference in direct material input.

AARON: Your predecessor is responsible. He believed that tracking the difference in direct material cost wasn't worth the effort. He simply didn't believe that it would make much difference in the unit cost of either model.

KAREN: Well, he may have been right, but I have my doubts. If there is a significant difference, it could affect our views of which model is more important to the company. The additional bookkeeping isn't very stringent. All we have to worry about is the Pattern Department. The other departments fit what I view as a process-costing pattern.

AARON: Why don't you look into it? If there is a significant difference, go ahead and adjust the costing system.

After the meeting, Karen decided to collect cost data on the two models: the Deluxe model and the Econo model. She decided to track the costs for one week. At the end of the week, she had collected the following data from the Pattern Department:

a. There were a total of 2,500 bows completed: 1,000 Deluxe models and 1,500 Econo models.
b. There was no beginning work in process; however, there were 300 units in ending work in process: 200 Deluxe and 100 Econo models. Both models were 80 percent complete with respect to conversion costs and 100 percent complete with respect to direct materials.
c. The Pattern Department experienced the following costs:

Direct materials	$114,000
Direct labour	45,667

d. On an experimental basis, the requisition forms for direct materials were modified to identify the dollar value of the direct materials used by the Econo and Deluxe models:

Econo model	$30,000
Deluxe model	84,000

Required:

1. Compute the unit cost for the handles produced by the Pattern Department assuming that process costing is totally appropriate.
2. Compute the unit cost of each handle using the separate cost information provided on materials.
3. Compare the unit costs computed in Requirements 1 and 2. Is Karen justified in her belief that a pure process-costing relationship is not appropriate? Describe the costing system that you would recommend.
4. In the past, the marketing manager has requested more money for advertising the Econo line. Aaron has repeatedly refused to grant any increase in this product's advertising budget because its per-unit profit (selling price less manufacturing cost) is so low. Given the results in Requirements 1 through 3, was Aaron justified in his position?

Problem 5-37 APPENDIX: NORMAL AND ABNORMAL SPOILAGE

OBJECTIVE 5 8

Larkin Company produces leather strips for western belts using three processes: cutting, design and colouring, and punching. The weighted average method is used for all three departments. The following information pertains to the Design and Colouring Department for the month of June:

a. There was no beginning work in process.
b. There were 400,000 units transferred in from Cutting.
c. Ending work in process, June 30: 50,000 strips, 80 percent complete with respect to conversion costs.
d. Units completed and transferred out: 330,000 strips. The following costs were added during the month:

Transferred in	$2,000,000
Direct materials	600,000
Conversion costs	780,000

e. Direct materials are added at the beginning of the process.
f. Inspection takes place at the end of the process. All spoilage is considered normal.

Required:

1. Calculate equivalent units of production for transferred-in materials, direct materials added, and conversion costs.
2. Calculate unit costs for the three categories of Requirement 1.
3. What is the total cost of units transferred out? What is the cost of ending work-in-process inventory? How is the cost of spoilage treated?
4. Assume that all spoilage is considered abnormal. Now, how is spoilage treated? Give the journal entry to account for the cost of the spoiled units. Some companies view all spoilage as abnormal. Explain why.
5. Assume that 80 percent of the units spoiled are abnormal and 20 percent are normal spoilage. Show the spoilage treatment for this scenario.

OBJECTIVE 8

Problem 5-38 APPENDIX: NORMAL AND ABNORMAL SPOILAGE IN PROCESS COSTING

Novel Toys Inc. manufactures plastic water guns. Each gun's left and right frames are produced in the Moulding Department. The left and right frames are then transferred to the Assembly Department, where the trigger mechanism is inserted and the halves are glued together. (The left and right halves together define the unit of output for the Moulding Department.) In June, the Moulding Department reported the following data:

a. In the Moulding Department, all direct materials are added at the beginning of the process.
b. Beginning work in process consisted of 3,000 units, 20 percent complete with respect to direct labour and overhead. Costs in beginning inventory included direct materials, $450; and conversion costs, $138.
c. Costs added to production during the month were direct materials, $950; and conversion costs, $2,174.50.
d. Inspection takes place at the end of the process. Malformed units are discarded. All spoilage is considered abnormal.
e. During the month, 7,000 units were started, and 8,000 good units were transferred out to Finishing. All other units finished were malformed and discarded. There were 1,000 units that remained in ending work in process, 25 percent complete.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production using the weighted average method.
3. Calculate the unit cost.
4. What is the cost of goods transferred out? Ending work in process? Loss due to spoilage?
5. Prepare the journal entry to remove spoilage from the Moulding Department.

OBJECTIVE 6 8

Problem 5-39 APPENDIX: NORMAL AND ABNORMAL SPOILAGE IN PROCESS COSTING, CHANGES IN OUTPUT MEASURES, MULTIPLE DEPARTMENTS

Gray Wolf Company produces an industrial chemical used for cleaning and lubricating machinery. In the Mixing Department, liquid and dry chemicals are blended to form slurry. Output is measured in litres. In the Baking Department, the slurry is subjected to high heat, and the residue appears in irregular lumps. Output is measured in kilograms. In the Grinding Department, the irregular lumps are ground into a powder, and this powder is placed in 50-kilogram bags. Output is measured in bags produced. In April, the company reported the following data:

a. The Mixing Department transferred 50,000 litres to the Baking Department, costing $250,000. Each litre of slurry weighs two kilograms.
b. The Baking Department transferred 100,000 kilograms (irregular lumps) to the Grinding Department. At the beginning of the month, there were 5,000 litres of slurry in process, 25 percent complete, costing $35,000 (transferred-in cost of $25,000 plus

conversion cost of $10,000). No additional direct materials are added in the Baking Department. At the end of April, there was no ending work in process. Conversion costs for the month totalled $205,000. Normal loss during baking is 5 percent of good output. All transferred-in materials are lost, but since loss occurs uniformly throughout the process, only 50 percent of the conversion units are assumed to be lost.

c. The Grinding Department transferred 2,500 bags of chemicals to its finished goods warehouse. Beginning work in process for this department was 25,000 kilograms, 40 percent complete with the following costs: transferred-in cost, $132,500; conversion cost, $15,000. Bags are used at the end of the process and cost $1.50 each. During bagging, normally one out of every 11 bags is torn and must be discarded. No powder is lost (the tearing occurs when the bag is being attached to a funnel). Conversion costs for the month's production are $172,500. There is no ending work in process.

Required:

1. Calculate the cost per bag of chemicals transferred to the finished goods warehouse. Show all work necessary for the calculation.
2. Prepare the journal entries needed to remove spoilage from the Baking and Grinding departments.

CMA Problem

CMA Problem 5-1 PROCESS COSTING*

Assume that Titan Corporation uses a FIFO process costing system and provides you with the following data:

- The opening inventory consists of 1,000 units, 80 percent complete as to direct materials, and 30 percent complete as to conversion.
- The total cost of the opening inventory was $8,000.
- 11,000 units are completed and transferred out.
- The closing inventory is 900 units, 40 percent complete as to direct materials, and 20 percent complete as to conversion.
- The current period costs per unit are $2.00 for direct materials and $8.00 for conversion.

Required:

Choose the correct answer for each of the following.

1. Total current direct materials costs amounted to
   a. $21,800
   b. $21,120
   c. $22,000
   d. $22,720
   e. $23,400
2. Total current conversion costs amounted to
   a. $86,390
   b. $86,680
   c. $87,040
   d. $89,380
   e. $89,440
3. Costs allocated to the goods transferred out amounted to
   a. $6,000
   b. $14,000
   c. $110,000
   d. $114,000
   e. $120,000

(Adapted from CMA Ontario)

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

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After studying this chapter, you should be able to:

1. Describe the basics of plantwide and departmental overhead costing.
2. Explain why plantwide and departmental overhead costing may not be accurate.
3. Provide a detailed description of activity-based product costing.
4. Explain how ABC can be simplified.

CHAPTER

6 Activity-Based Costing

In Chapter 1, we mentioned that cost management information systems can be divided into two types: unit-based and activity-based. The unit-based costing systems use only unit-based activity drivers to assign overhead to products. This chapter begins by describing how unit-based costing is used for computing traditional product costs. This enables us to compare and contrast unit-based and activity-based costing approaches. An activity-based cost accounting system offers greater product costing accuracy but at an increased cost. The justification for adopting an activity-based costing approach must rely on the benefits of improved decision making. It is important to understand that a necessary condition for improved decisions is that the accounting numbers produced by an activity-based costing system be significantly different from those produced by a unit-based costing system. When will this be the case? Are there any signals that indicate unit-based costing is no longer working? Finally, assuming that an activity-based cost accounting system is called for, how does it work? What are its features? What steps must be followed for successful implementation of an ABC system? This chapter addresses these questions and other related issues.

Unit-Based Product Costing

OBJECTIVE 1
Describe the basics of plantwide and departmental overhead costing.

Unit-based product costing assigns only manufacturing costs to products. Assigning the cost of direct materials and direct labour to products poses no particular challenge. These costs can be assigned to products using direct tracing, and most unit-based costing systems are designed to ensure that this tracing takes place. Overhead costs, on the other hand, pose a different problem. The physically observable input–output relationship that exists between direct labour, direct materials, and products is simply not available for overhead. Thus, assignment of overhead must rely on a predetermined overhead rate based on unit-based drivers.

A **predetermined overhead rate** is calculated at the beginning of the year using the following formula:

$$\text{Overhead rate} = \text{Budgeted annual overhead}/\text{Budgeted annual driver units}$$

Predetermined overhead rates are used because overhead and production often are incurred nonuniformly throughout the year, and it is not possible to wait until the end of the year to calculate the actual overhead cost assignments (managers need unit product cost information throughout the year). A cost system that uses predetermined overhead rates for overhead and actual costs for direct materials and direct labour is referred to as a **normal costing system**. Budgeted overhead is simply the firm's best estimate of the amount of overhead (utilities, indirect labour, depreciation, etc.) to be incurred in the coming year. The estimate is often based on last year's figures, adjusted for anticipated changes in the coming year. Budgeted annual driver units represent the predicted activity driver units. Assignment of overhead costs should follow, as nearly as possible, a cause-and-effect relationship, and the ***unit-based drivers*** used simply measure the consumption of overhead by products. The five most commonly used unit-level drivers are:

1. Units produced
2. Direct labour hours
3. Direct labour dollars
4. Direct machine hours
5. Direct material dollars

The use of only unit-based drivers to assign overhead costs to products assumes that all overhead consumed by products is highly correlated with the number of units produced. Thus, the higher the units of product produced, the higher the unit-level drivers consumed. To the extent that this assumption is true, unit-based costing can produce accurate cost assignments.

Plantwide or departmental predetermined overhead rates are used to assign or apply overhead costs to production according to the actual production activity. The total overhead assigned to actual production at any point in time is called **applied overhead**. Applied overhead is computed using the following formula:

$$\text{Applied overhead} = \text{Overhead rate} \times \text{Actual driver usage}$$

Once the applied overhead is assigned, the unit cost is calculated by dividing the total applied overhead by the units produced.

Overhead Application: Plantwide Rates

For plantwide rates, all budgeted overhead costs are assigned to a single plantwide pool. Next, a plantwide rate is computed using a single unit-level driver, which is usually direct labour hours. Finally, overhead costs are assigned to products by multiplying the rate by the actual total direct labour hours used by each product (second-stage assignment). The corresponding calculations and their rationales are illustrated in Cornerstone 6-1.

CORNERSTONE 6-1

The HOW and WHY of Applied Overhead and Unit Overhead Cost: Plantwide Rates

Information:

PlayFun Inc. produces two types of battery-operated toys: robots and race cars. Its plant uses a plantwide rate based on direct labour hours to assign its overhead costs. The company has the following estimated and actual data for the coming year:

Estimated overhead	$350,000
Expected activity	50,000
Actual activity (direct labour hours):	
Robots	10,000
Race cars	40,000
Units produced:	
Robots	50,000
Race cars	250,000

Why:

Product cost information is needed for such things as financial statement preparation, pricing decisions, and keep-or-drop decisions. Predetermined overhead rates (based on expected overhead and expected activity) are used because overhead and production are incurred nonuniformly and managers cannot wait until the end of the year to obtain product cost information. A plantwide rate is used under the assumption that all overhead costs are largely caused by a single, unit-level cost driver such as direct labour hours or machine hours.

Required:

1. Calculate the predetermined plantwide overhead rate and the applied overhead for each product, using direct labour hours.
2. Calculate the overhead cost per unit for each product.
3. ***What if*** robots used 5,000 hours (to produce 50,000 units) instead of 10,000 hours? Calculate the effect on the profitability of this product line if all 50,000 units are sold, and then discuss the implications of this outcome.

Solution:

1. Plantwide rate = $350,000/50,000 = $7.00 per hour

   Applied overhead:

	Robots	Race Cars
$7.00 × 10,000	$70,000	
$7.00 × 40,000		$280,000

2. Overhead per unit (robots) = $70,000/50,000 = $1.40
   Overhead per unit (race cars) = $280,000/250,000 = $1.12

3. There would be a reduction of $35,000 ($7.00 × 5,000) of overhead assigned to the robots and so profitability for this product line would increase by this amount. Overhead assignments affect product cost and profitability and thus can affect many decisions (e.g., pricing). This conclusion, in turn, implies that the way overhead is assigned is important.

Calculation and Disposition of Overhead Variances

From Cornerstone 6-1, the initial calculation of applied overhead is $350,000. It is possible (and likely) that the applied amount in a period differs from the actual overhead incurred for the period. Since the predetermined overhead rate is based on estimated data, applied overhead will rarely equal actual overhead. The difference between actual overhead and applied overhead is an **overhead variance**. If actual overhead is greater than applied overhead, then the variance is called **underapplied overhead**. If applied overhead is greater than actual overhead, then the variance is called **overapplied overhead**.

Overhead variances occur because it is impossible to perfectly estimate future overhead costs and production activity. Accordingly, at the end of a reporting period, procedures must exist to dispose of any overhead variance. An overhead variance is disposed of in one of two ways:

1. If immaterial, it is assigned to cost of goods sold.
2. If material, it is allocated among work-in-process inventory, finished goods inventory, and cost of goods sold.

The most common practice is simply to assign the entire overhead variance to cost of goods sold. This practice is justified on the basis of materiality, the same principle used to justify expensing the entire cost of a pencil sharpener in the period acquired rather than allocating (through depreciation) its cost over the life of the sharpener. Thus, the overhead variance is added to cost of goods sold if underapplied and subtracted from cost of goods sold if overapplied. A journal entry is the mechanism for adding or subtracting the overhead variance. Cost of Goods Sold would be debited (credited) if under- (over-) applied.

If the overhead variance is material, it should be allocated to the period's production. Conceptually, the overhead costs of a period belong to goods started but not completed (work-in-process inventory), goods finished but not sold (finished goods inventory), and goods finished and sold (cost of goods sold). The recommended way to achieve this allocation is to *prorate the overhead variance based on the ending applied overhead balances in each account.* Using applied overhead captures the original cause-and-effect relationships used to assign overhead. Using another balance to prorate, such as total manufacturing costs, may result in an unfair assignment of the additional overhead. For example, two products identical on all dimensions except for the cost of direct material inputs should receive the same overhead assignment. Yet if total manufacturing costs were used to allocate an overhead variance, then the product with the more expensive direct materials would receive a higher overhead assignment. The prorating adds the amount to each account if underapplied and subtracts an amount from each account if overapplied. Again, a journal entry is the mechanism used. Cornerstone 6-2 illustrates the calculation and disposal of overhead variances.

Overhead Application: Departmental Rates

Under departmental rates, overhead costs are assigned to individual production departments, creating departmental overhead cost pools. Budgeted overhead costs are assigned using direct tracing, driver tracing, and allocation. Once costs are assigned to individual production departments, then unit-level drivers such as direct labour hours (for labour-intensive departments) and machine hours (for machine-intensive departments) are used to compute predetermined overhead rates for each department. Products passing through the departments are assumed to consume overhead resources in proportion to the departments' unit-based drivers (machine hours or direct labour hours used). Overhead is assigned to products by multiplying the departmental rates by the amount of the driver used in the respective departments. The total overhead assigned to each department is equal to the total overhead assigned to products. Increased accuracy is the usual justification offered for the use of departmental rates.

The PlayFun example will again be used to illustrate departmental rates. Assume that PlayFun has two producing departments: Moulding and Assembly. Machine

CORNERSTONE 6-2

The HOW and WHY of Overhead Variances and Their Disposal

Information:

PlayFun Inc.'s plant produces two types of battery-operated toys: robots and race cars. The company has the following data for the past year:

Actual overhead	$380,000	
Applied overhead:		Prorate Percentage
Work-in-process inventory	$ 70,000	20% ($70,000/$350,000)
Finished goods inventory	105,000	30% ($105,000/$350,000)
Cost of goods sold	175,000	50% ($175,000/$350,000)
Total	$350,000	100%

The PlayFun plant uses the overhead control account to accumulate both actual and applied overhead.

Why:

At the end of the period, the total actual amount of overhead incurred must be reported as a product cost. Financial reports use actual production costs and, thus, applied and actual overhead must be reconciled. First, the difference is calculated: Actual overhead − Applied overhead (called an overhead variance). Next, the variance balance, which is either under- or overapplied overhead, must be removed through an adjustment at the end of the period. If the amount of the overhead variance is not material, then it is typically closed out to cost of goods sold. If material, the variance is prorated among Work in Process, Finished Goods, and Cost of Goods Sold.

Required:

1. Calculate the overhead variance for the year and close it to Cost of Goods Sold.
2. Assume the variance calculated is material. After prorating, close the variances to the appropriate accounts and provide the final ending balances of these accounts.
3. ***What if*** the variance is overapplied instead of underapplied? Provide the appropriate adjusting journal entries (if immaterial and then if material).

Solution:

1. Overhead variance = $380,000 − $350,000 = $30,000 underapplied

Cost of Goods Sold	30,000	
Overhead Control		30,000

2. Proration: (0.20 × $30,000; 0.30 × $30,000; 0.50 × $30,000)

Work-in-Process Inventory	6,000	
Finished Goods Inventory	9,000	
Cost of Goods Sold	15,000	
Overhead Control		30,000

CORNERSTONE 6-2 *(continued)*

	Unadjusted Balance	Prorated Underapplied Overhead	Adjusted Balance
Work-in-Process Inventory	$ 70,000	$ 6,000	$ 76,000
Finished Goods Inventory	105,000	9,000	114,000
Cost of Goods Sold	175,000	15,000	190,000

3.

Overhead Control	30,000	
Cost of Goods Sold		30,000

Overhead Control	30,000	
Work-in-Process Inventory		6,000
Finished Goods Inventory		9,000
Cost of Goods Sold		15,000

hours are used to assign the overhead of moulding, and direct labour hours are used to assign the overhead of assembly. Cornerstone 6-3 illustrates the calculations and summarizes their rationale.

Limitations of Plantwide and Departmental Rates

OBJECTIVE 2
Explain why plantwide and departmental overhead costing may not be accurate.

Plantwide and departmental rates have been used for a long time by many organizations. In some settings, however, they do not work well and may actually cause severe product cost distortions. Of course, to cause a significant cost distortion, overhead costs must be a significant percentage of total manufacturing costs. For some manufacturers, overhead costs are a small percentage (e.g., 5 percent or less), and therefore no matter what method is used to apply overhead, there is little difference in the per-unit costs. In this case, using a very simple, uncomplicated approach such as plantwide rates is appropriate. Assuming, however, that the overhead costs are a significant percentage of total manufacturing costs, at least two major factors can impair the ability of the unit-based plantwide and departmental rates to assign overhead costs accurately: (1) the proportion of non-unit-related overhead costs to total overhead costs is large, and (2) the degree of product diversity produced and the amount of overhead each product consumes are great.

1. Non-Unit-Related Overhead Costs

The use of either plantwide rates or departmental rates assumes that a product's consumption of overhead resources is related strictly to the units produced. But what if there are overhead activities that are unrelated to the number of units produced? Setup costs, for example, are incurred each time a batch of products is produced. A batch may consist of 1,000 or 10,000 units, and the cost of setup is the same. Yet as more setups are done, setup costs increase. The number of setups, not the number of units produced, is the cause of setup costs. Furthermore, product engineering costs may depend on the number of different engineering work orders rather than the units produced of any given product. Both these examples illustrate the existence of non-unit-based drivers. **Non-unit-based drivers** are factors, other than the number of units produced, that measure the demands that cost objects place on activities.

CORNERSTONE 6-3

The HOW and WHY of Departmental Overhead Rates

Information:

The data for the two producing departments of the PlayFun Inc. plant are given below.

	Moulding	Assembly	Total
Estimated overhead	$250,000	$100,000	$350,000
Direct labour hours (expected and actual):			
Robots	5,000	5,000	10,000
Race cars	5,000	35,000	40,000
Total	10,000	40,000	50,000
Machine hours:			
Robots	17,000	3,000	20,000
Race cars	3,000	7,000	10,000
Total	20,000	10,000	30,000

Machine hours are used to assign the overhead of the Moulding Department, and direct labour hours are used to assign the overhead of the Assembly Department. There are 50,000 robots produced and sold and 250,000 race cars.

Why:

Product costs that reflect the consumption of resources actually used are relatively more accurate and improve decision making and control. Overhead intensity and patterns of consumption by products can differ from department to department. The argument is that departmental overhead rates will better reflect each product's use of resources and thus will be more accurate than a single plantwide rate.

Required:

1. Calculate the overhead rates for each department.
2. Assign overhead to the two products and calculate the overhead cost per unit. How does this compare with the plantwide rate unit cost of Cornerstone 6-1?
3. ***What if*** the machine hours in Moulding were 5,000 for robots and 15,000 for race cars and the direct labour hours used in Assembly were 4,000 and 36,000, respectively? Calculate the overhead cost per unit for each product, and compare with the plantwide rate unit cost of Cornerstone 6-1. What can you conclude from this outcome?

Solution:

1. Moulding: $250,000/20,000 = $12.50 per machine hour
   Assembly: $100,000/40,000 = $2.50 per direct labour hour
2. Overhead assignment:

	Robots	Race Cars
($12.50 × 17,000) + ($2.50 × 5,000)	$225,000	
($12.50 × 3,000) + ($2.50 × 35,000)		$125,000

CORNERSTONE 6-3 *(continued)*

	Robots	Race Cars
Total applied overhead	$225,000	$125,000
Units of production	÷ 50,000	÷ 250,000
Unit overhead cost	$ 4.50	$ 0.50

The cost increased dramatically for robots (from $1.40 to $4.50) and decreased significantly for race cars (from $1.12 to $0.50).

3. Overhead assignment:

	Robots	Race Cars
($12.50 × 5,000) + ($2.50 × 4,000)	$72,500	
($12.50 × 15,000) + ($2.50 × 36,000)		$277,500
Total applied overhead	$72,500	$277,500
Units of production	÷ 50,000	÷ 250,000
Unit overhead cost	$ 1.45	$ 1.11

Compared to the plantwide unit overhead costs, the cost is $0.05 more for robots and $0.01 less for racing cars. The message is that departmental rates may not necessarily cause a significant change in the assignments. It depends on the complexity of each product and how the resource demands are made in each department. However, implementation of departmental rates would probably be done based on the observation that significant differences in resource consumption do exist, justifying the decision.

Thus, unit-level drivers cannot assign these costs accurately to products. In fact, using only unit-level drivers to assign non-unit-related overhead costs can create distorted product costs. The severity of this distortion depends on what proportion of total overhead costs these non-unit-based costs represent. For many companies, this percentage can be significant—reaching more than 40 or 50 percent of the total. Clearly, as this percentage decreases, the acceptability of using unit-based drivers for assigning costs increases.

2. Product Diversity

Significant non-unit overhead costs will not cause product cost distortions provided that products consume the non-unit overhead activities in the same proportion as the unit-level overhead activities. Product diversity, on the other hand, can cause product cost distortion. **Product diversity** simply means that different products consume overhead activities in different proportions. Product diversity is caused by such things as differences in product size, product complexity, setup time, and size of batches. The proportion of each activity consumed by a product is referred to as the **consumption ratio**. The way that non-unit overhead costs and product diversity can produce distorted product costs (when only unit-level drivers are used to assign overhead costs) will be illustrated by providing detailed data for PlayFun Inc.

To illustrate the failure of plantwide and departmental rates, let's once again consider PlayFun's plant, which produces battery-operated toy robots and race cars. The two producing departments are Moulding and Assembly. Moulding is responsible for shaping the plastic components of each product, and Assembly is responsible for assembling the internally produced plastic components with outside purchased

Exhibit 6-1

Product Costing Data

I. *Activity Usage Measures (expected and actual)*

	Robots	Race Cars	Total
Units produced	50,000	250,000	—
Prime costs	$200,000	$750,000	$950,000
Direct labour hours	10,000	40,000	50,000
Machine hours	20,000	10,000	30,000
Number of setups	25	75	100
Inspection hours	1,200	2,800	4,000
Number of moves	140	210	350

II. *Departmental Data (expected and actual)*

	Moulding	Assembly	Total
Direct labour hours:			
Robots	5,000	5,000	10,000
Race cars	5,000	35,000	40,000
Total	10,000	40,000	50,000
Machine hours:			
Robots	17,000	3,000	20,000
Race cars	3,000	7,000	10,000
Total	20,000	10,000	30,000
Overhead costs:			
Machining	$120,000	$ 30,000	$150,000
Moving materials	40,000	30,000	70,000
Setting up	70,000	10,000	80,000
Inspecting products	20,000	30,000	50,000
Total	$250,000	$100,000	$350,000

electronic parts. Expected product costing data are given in Exhibit 6-1. Because the quantity of race cars produced is five times greater than that of robots, we can label the race cars a high-volume product and robots a low-volume product. Because different moulds are needed, the products are produced in batches. The moulds for robots are larger and more varied than those for race cars; thus, batches for robots tend to be smaller and take longer to process.

For ease of presentation, only four types of overhead activities, performed by four distinct support departments, are assumed: setting up the equipment for each batch, machining, inspecting, and moving a batch. Each batch of products is inspected after each department's operations. After moulding, a sample of the components is inspected to ensure correct size and shape. After assembly, a sample is also tested to ensure that each unit works as expected. Overhead costs are assigned to the two production departments using the direct method. Effectively, costs are assigned using direct and driver tracing.

Plantwide Departmental Overhead and Activity Rates

The traditional unit product cost is the unit prime cost plus unit overhead cost. Prime costs are assigned to each of the products using direct tracing. From Exhibit 6-2, the unit prime cost for robots is $4.00 ($200,000/50,000), and the unit prime cost for race cars is $3.00 ($750,000/250,000). Cornerstones 6-1 and 6-3 provide the unit overhead cost calculations for plantwide and overhead rates. Adding the unit

Exhibit 6-2

Unit Product Cost: Plantwide and Departmental Rates

I. *Plantwide*

	Robots	Race Cars
Prime cost[a]	$4.00	$3.00
Overhead cost[b]	1.40	1.12
Unit cost	$5.40	$4.12

II. *Departmental*

Prime cost[a]	$4.00	$3.00
Overhead cost[c]	4.50	0.50
Unit cost	$8.50	$3.50

[a] $200,000/50,000; $750,000/250,000
[b] From Cornerstone 6-1
[c] From Cornerstone 6-3

prime costs to the unit overhead costs produces the desired unit product cost. Exhibit 6-2 summarizes and provides the details of these calculations.

Problems with Costing Accuracy The accuracy of the overhead cost assignment can be challenged regardless of whether plantwide or departmental rates are used. The main problem with either procedure is the assumption that machine hours and/or direct labour hours drive or cause all overhead costs.

From Exhibit 6-1, we know that race cars, the high-volume product, use four times the direct labour hours used by robots, the low-volume product (40,000 hours versus 10,000 hours). Thus, if a plantwide rate is used, the race cars will receive four times more overhead cost than will the robots. But is this reasonable? Do unit-based activity drivers explain the consumption of all overhead activities? In particular, can we reasonably assume that each product's consumption of overhead increases in direct proportion to the direct labour hours used? Let's look at the four overhead activities and see if unit-based drivers accurately reflect the demands of the two products for overhead resources.

Of the four activities, only machining appears to be a unit-level cost, since machining will occur each time a unit is produced. Thus, using direct labour hours or machine hours on the surface appears reasonable. However, the data in Exhibit 6-1 suggest that a significant portion of overhead costs is not driven or caused by the units produced (measured by direct labour hours). For example, each product's demands for the setup, material moving, and inspection activities are more logically related to the number of setups, number of moves, and inspection hours, respectively. These non-unit-level activities represent more than 50 percent ($200,000/$350,000) of the total overhead costs—a significant percentage. Notice that the high-volume product, race cars, uses three times the number of setups of robots, about 2.33 times as many inspection hours, and only one and one-half times as many moves. However, use of direct labour hours, a unit-based activity driver, and a plantwide rate assigns four times more setup, inspection, and materials handling costs to the race cars than to the robots. Thus, we have product diversity, and we should expect product cost distortion because the quantity of unit-based overhead that each product consumes does not vary in direct proportion to the quantity consumed of non-unit-based overhead. How to calculate the consumption ratios for the various activities is shown in Cornerstone 6-4. Consumption ratios are simply the proportion of each activity consumed by a product. The *assumed* consumption ratios can also be calculated for the plantwide and overhead rates. Comparing the

CORNERSTONE 6-4

The HOW and WHY of Consumption Ratios

Information:

Product costing data from Exhibit 6-1.

Why:

Consumption ratios reflect the proportion of an activity consumed by the individual products. They are especially useful to assign costs of a shared resource. For example, two individuals sharing the cost of a pizza would logically do so in proportion to the amount of the pizza consumed. In a multiple-product firm, there are many shared resources and it is reasonable to assign the costs of shared resources in proportion to the resource consumed. Activity drivers are a measure of activity output and thus can be used as measures of activity consumption.

Required:

1. Calculate the activity consumption ratios for each product.
2. Calculate the *assumed* consumption ratios for plantwide (direct labour hours) and departmental rates.
3. ***What if*** the activity consumption ratios were approximately equal to the consumption ratio associated with direct labour hours? What does this tell you?

Solution:

1.

	Consumption Ratios		
Overhead Activity	**Robots**	**Race Cars**	**Activity Driver**
Machining	0.67[a]	0.33[a]	Machine hours
Setups	0.25[b]	0.75[b]	Number of setups
Inspecting products	0.30[c]	0.70[c]	Inspection hours
Moving materials	0.40[d]	0.60[d]	Number of moves

[a] 20,000/30,000 (robots) and 10,000/30,000 (race cars)
[b] 25/100 (robots) and 75/100 (race cars)
[c] 1,200/4,000 (robots) and 2,800/4,000 (race cars)
[d] 140/350 (robots) and 210/350 (race cars)

2.

	Consumption Ratios		
Overhead Activity	**Robots**	**Race Cars**	**Activity Driver**
Plantwide:			
Manufacturing	0.20[a]	0.80[a]	Direct labour hours
Departmental:			
Moulding	0.85[b]	0.15[b]	Machine hours
Assembly	0.13[c]	0.87[c]	Direct labour hours

[a] 10,000/50,000 (robots) and 40,000/50,000 (race cars)
[b] 17,000/20,000 (robots) and 3,000/20,000 (race cars)
[c] 5,000/40,000 (robots) and 35,000/40,000 (race cars)

3. If the activity ratios were approximately the same (all about 0.20 and 0.80 for each product, respectively), it would indicate that there is little product diversity—that the products are consuming all activities in the same ratio as direct labour hours. This outcome would signal that a plantwide rate is functioning quite well in assigning overhead costs to products. There would be no need to use either departmental or activity rates.

consumption ratios with the assumed consumption pattern of a plantwide rate suggests that using only direct labour hours to assign costs will overcost the race cars and undercost the robots. Comparing the departmental consumption ratios with the plantwide ratios (in Cornerstone 6-4) and the product costs illustrated in Exhibit 6-2 indicates that the departmental rates are likely making a correction in the right direction (more overhead is being assigned to the robots and less to the race cars), but whether the correction is about right, too little, or too much can be assessed by calculating activity-based costs.

The most direct method of overcoming the distortions caused by the unit-level rates is to expand the number of rates used so that the rates reflect the actual consumption of overhead costs by the various products. Thus, instead of pooling the overhead costs in plant or departmental pools, rates are calculated for each individual overhead activity. The rates are based on causal factors that measure consumption (unit- and non-unit-level activity drivers). Costs are assigned to each product by multiplying the activity rates by the amount consumed by each activity (as measured by the activity driver). Cornerstone 6-5 illustrates the calculations and summarizes the rationale for activity-based costing.

Comparison of Different Product Costing Methods In Exhibit 6-3, the unit costs and unit overhead costs from activity-based costing are compared with the unit costs produced by unit-based costing using either a plantwide or departmental rate. This comparison clearly illustrates the effects of using only unit-based activity drivers to assign overhead costs. The activity-based cost assignment follows a cause-and-effect pattern of overhead consumption and is therefore the most accurate of the three costs shown in Exhibit 6-3. Using a plantwide overhead rate undercosts the robots and overcosts the race cars. In fact, relative to the ABC cost, the plantwide assignment decreases the total unit cost of the robots by at least 25 percent [($7.26 − $5.40)/$7.26] and increases the unit cost of the race cars by about 10 percent [($4.12 − $3.75)/$3.75]. The effect is even more dramatic when comparing only unit overhead costs. Departmental overhead rates overcorrect and produce distortions as well, although, in this example, the distortion is reduced (about a 17 percent error for robots and 7 percent for race cars, relative to ABC assignments). Thus, in the presence of significant non-unit overhead costs and product diversity, using only unit-based activity drivers can lead to one product subsidizing another (for plantwide rates, the race cars subsidize the robots). This subsidy could create the appearance that one group of products is highly profitable and can adversely impact the pricing and competitiveness of another group of products. In a highly competitive environment, the more accurate the cost information, the better the planning and decision making.

The PlayFun example also helps us understand when ABC may be useful for a firm. First, ABC offers no increase in product costing accuracy for a single-product setting; there must be product diversity. Second, if products consume non-unit-level activities in the same proportion as unit-level activities, then ABC assignments will be the same as unit-based assignments. Third, non-unit-level overhead must be a significant percentage of production cost. If it is not, then it hardly matters how it is assigned. Thus, firms that have plants with multiple products, high product diversity, and significant non-unit-level overhead are candidates for an ABC system.

Exhibit 6-3

Comparison of Unit Costs

	Total Unit Cost			Unit Overhead Cost		
	Robots	Race Cars		Robots	Race Cars	
Activity-based cost	$7.26	$3.75	Cornerstone 6-5	$3.26	$0.75	Cornerstone 6-5
Unit-based cost:						
Plantwide rate	5.40	4.12	Exhibit 6-2	1.40	1.12	Cornerstone 6-1
Departmental rates	8.50	3.50	Exhibit 6-2	4.50	0.50	Cornerstone 6-3

CORNERSTONE 6-5

The HOW and WHY of Activity-Based Costing

Information:

Activity usage and costs from Exhibit 6-1:

	Robots	Race Cars	Total
Units produced	50,000	250,000	—
Prime costs	$200,000	$750,000	$950,000
Machine hours	20,000	10,000	30,000
Number of setups	25	75	100
Number of moves	140	210	350
Inspection hours	1,200	2,800	4,000

Overhead costs:	
Machining	$150,000
Setting up	80,000
Moving materials	70,000
Inspecting products	50,000

Why:

An activity rate is calculated for each activity and the activity cost is assigned to products based on how much they use of each activity. The assignment is done using cause-and-effect relationships. Causal factors, called activity drivers, measure the amount of activity consumed by a product. The activity rate multiplied by the amount used of the activity determines the amount of activity cost assigned to a particular product. The total of all the assigned activity costs is the amount of overhead consumed by a product. Because the assignment uses causal factors, it tends to be *relatively* more accurate than assignments that use only unit-level drivers.

Required:

1. Calculate the four activity rates.
2. Calculate the unit costs using activity rates. Also, calculate the overhead cost per unit (see Exhibit 6-2 for unit prime costs).
3. ***What if*** consumption ratios were used to assign costs instead of activity rates? Show the cost assignment for moving materials.

Solution:

1. Machining rate: $150,000/30,000 = $5.00 per machine hour
   Setup rate: $80,000/100 = $800 per setup
   Moving materials rate: $70,000/350 = $200 per move
   Inspecting rate: $50,000/4,000 = $12.50 per hour

2.

	Robots	Race Cars
Prime costs	$200,000	$750,000
Overhead costs:		
Machining:		
$5 × 20,000	100,000	
$5 × 10,000		50,000

CORNERSTONE 6-5 *(continued)*

	Robots	Race Cars
Setting up:		
$800 × 25	$ 20,000	
$800 × 75		$ 60,000
Moving materials:		
$200 × 140	28,000	
$200 × 210		42,000
Inspecting products:		
$12.50 × 1,200	15,000	
$12.50 × 2,800		35,000
Total manufacturing costs	$363,000	$937,000
Units of production	÷ 50,000	÷ 250,000
Unit cost	$ 7.26	$ 3.75 (rounded)

Overhead cost per unit: Robots: $7.26 − $4.00* = $3.26
Cars: $3.75 − $3.00* = $0.75

*Prime cost per unit:
Robots = $200,000 ÷ 50,000 = $4.00
Cars = $750,000 ÷ 250,000 = $3.00

3. Using consumption ratios will yield exactly the same overhead assignments as activity rates, if the actual activity usage is the same as the expected usage (assuming no rounding error for the ratios). For moving materials, the consumption ratio is 0.40 for robots and 0.60 for race cars. Thus, the assignment is 0.40 × $70,000 = $28,000 (robots) and 0.60 × $70,000 = $42,000 (race cars), which is the same assignment obtained using activity rates.

One survey studied this concept.[1] Of those firms surveyed, 49 percent had adopted ABC. When compared with non-adopting firms, it was found that adopting firms reported a higher potential for distorted costs and a higher level of overhead when expressed as a percentage of total production costs. Adopting firms also reported a greater need or utility for accurate cost information for decision making.

Activity-Based Costing System

OBJECTIVE 3
Provide a detailed description of activity-based product costing.

The PlayFun example shows quite clearly that prime costs are assigned in the same way for functional as for activity-based costing. The example also demonstrates that the total amount of overhead costs is assigned under either approach. The amount assigned to each product, though, can differ significantly, depending on which method is used. The theoretical premise of activity-based costing is that it assigns costs according to the resource consumption of each product. If this is true, then activity-based costing should produce more accurate product costs if there is product diversity simply because unit-based drivers cannot capture the full consumption pattern of products. The PlayFun example suggests that we simply need to choose among a plantwide cost pool, departmental cost pools, or activity cost pools. If there is no product diversity and a plantwide cost pool is chosen, all we need is the cost of overhead resources: depreciation, salaries, utilities, rent, and so forth. On the other hand, departmental cost pools require more detail because costs must be assigned to every producing

[1] Kip Krumwiede, "ABC: Why It's Tried and How It Succeeds," *Management Accounting* (April 1998): 32–38.

Exhibit 6-4

Activity-Based Costing Model

department. Finally, activity-based costing requires the most detail because each activity performed and its associated costs must be identified.

As Exhibit 6-4 illustrates, an **activity-based costing (ABC) system** first traces costs to activities and then to products and other cost objects. The underlying assumption is that activities consume resources, and that products and other cost objects consume activities. In designing an ABC system, there are six essential steps, as listed in Exhibit 6-5.

Step 1: Identify, Define, and Classify Activities

Identifying activities is a logical first step in designing an activity-based costing system. Activities represent actions taken or work performed. Identifying an activity is equivalent to describing action taken—usually by using an action verb and an object that receives the action. A simple list of the activities identified is called an **activity inventory**. A sample activity inventory for an electronics manufacturer is listed in Exhibit 6-6. Of course, the actual inventory of activities for most organizations would list more than 12 activities (220 to 300 are not uncommon).

Exhibit 6-5

Design Steps for an ABC System

Stage I (identify, classify, and determine cost of each activity)

1. Identify, define, and classify activities.
2. Assign the cost of resources to each activity.
3. Assign the cost of secondary activities to primary activities.

Stage II (determine rates for each activity, consumption of each activity, and assign activity costs to products/services)

4. Identify cost objects and specify the amount of each activity consumed by each cost object.
5. Calculate primary activity rates.
6. Assign activity costs to cost objects.

Exhibit 6-6

Sample Activity Inventory

1. Providing space
2. Providing utilities
3. Purchasing materials
4. Receiving materials
5. Paying for materials
6. Collecting engineering data
7. Developing test programs
8. Testing products
9. Setting up lots
10. Handling wafer lots

Activity Definition Once an inventory of activities exists, then activity attributes are used to define activities. **Activity attributes** are nonfinancial and financial information items that describe individual activities. An **activity dictionary** lists the activities in an organization along with desired attributes. The attributes selected depend on the purpose being served. Examples of activity attributes with a product costing objective include tasks that describe the activity, types of resources consumed by the activity, amount (percentage) of time spent on an activity by workers, cost objects that consume the activity, and a measure of activity consumption (activity driver). Activities are the building blocks for both product costing and continuous improvement.

Activity Classification Attributes define and describe activities and, at the same time, become the basis for activity classification. Activity classification facilitates the achievement of key managerial objectives such as product or customer costing, continuous improvement, total quality management, and environmental cost management. For example, for costing purposes, activities can be classified as primary or secondary. A **primary activity** is an activity that is consumed by a final cost object such as a product or customer. A **secondary activity** is one that is consumed by intermediate cost objects such as primary activities, materials, or other secondary activities. Recognizing the difference between the two types of activities facilitates product costing. Exhibit 6-4 indicates that activities consume resources. Thus, in the first stage of activity-based costing, the cost of resources is assigned to activities. Exhibit 6-4 also reveals that products consume activities—but only primary activities. Thus, before assigning the costs of primary activities to products, the costs of the secondary activities consumed by primary activities must be assigned to the primary activities. Many other useful activity classifications exist. For example, activities can be classified as *value-added* or *non-value-added* (defined and discussed in detail in Chapter 14), as *quality-related* or as *environmental* (discussed in Chapter 16). In designing an activity costing system, the desired attributes and essential classifications need to be characterized up front so that the necessary data can be collected for the activity dictionary.

Gathering the Necessary Data Interviews, questionnaires, surveys, and observation are means of gathering data for an ABC system. Interviews with managers or other knowledgeable representatives of functional departments are perhaps the most common approach for gathering the needed information. Interview questions can be used to identify activities and activity attributes needed for costing or other managerial purposes. The information derived from interview questions serves as the basis for constructing an activity dictionary and provides data helpful for assigning resource costs to individual activities. In structuring an interview, the questions should reveal certain key attributes. Interview questions should be structured to provide answers that allow the desired attributes to be identified and measured. An example is perhaps the best way to show how an interview can be used to collect the data for an activity dictionary.

Illustrative Example Suppose that a hospital is carrying out an ABC pilot study to determine the nursing cost for different types of cardiology patients. The cardiology unit is located on one floor of the hospital. The interview with the unit's nursing supervisor is provided below. Questions are given along with their intended purposes and the supervisor's responses. The interview is not intended to be viewed as an exhaustive analysis but rather represents a sample of what could occur.

Question 1 (Activity Identification): Can you describe what your nurses do for patients in the cardiology unit? (Activities are people doing things for other people.)

Response: There are four major activities: treating patients (administering medicine and changing dressings), monitoring patients (checking vital signs and posting patient information), providing hygienic and physical care for patients (bathing, changing bedding and clothes, walking the patient, etc.), and responding to patient requests (counselling, providing snacks, and answering calls).

Question 2 (Activity Identification): Do any patients make use of any equipment? (Activities also can be equipment doing work for other people.)

Response: Yes. In the cardiology unit, monitors are used extensively. Monitoring is an important activity for this type of patient.

Question 3 (Activity Identification): What role do you have in the cardiology unit? (Activities are people doing things for other people.)

Response: I have no direct contact with the patients. I am responsible for scheduling, evaluations, and resolving problems with the ward's nurses.

Question 4 (Resource Identification): What resources are used by your nursing care activities (equipment, materials, energy)? (Activities consume resources in addition to labour.)

Response: Uniforms (which are paid for by the hospital), computers, nursing supplies such as scissors and instruments (supplies traceable to a patient are charged to the patient), and monitoring equipment at the nursing station.

Question 5 (Resource Driver Identification): How much time do nurses spend on each activity? How much equipment time is spent on each activity? (Information is needed to assign the cost of labour and equipment to activities.)

Response: We recently completed a work survey. About 25 percent of a nurse's time is spent treating patients, 20 percent providing hygienic care, 40 percent responding to patient requests, and 15 percent on monitoring patients. My time is 100 percent supervision. The monitoring equipment is used 100 percent for monitoring activity. Use of the computer is divided between 40 percent for supervisory work and 60 percent for monitoring. (Posting readings to patient records is viewed as a monitoring task.)

Question 6 (Potential Activity Drivers): What are the outputs of each activity? That is, how would you measure the demands for each activity? (This question helps identify activity drivers.)

Response: Treating patients: number of treatments; providing hygienic care: hours of care; responding to patient requests: number of requests; and monitoring patients: monitoring hours.

Question 7 (Potential Cost Objects Identified): Who or what uses the activity output? (Identifies the cost object: products, other activities, customers, etc.)

Response: Well, for supervising, I schedule, evaluate performance, and try to ensure that the nurses carry out their activities efficiently. Nurses benefit from what I do. Patients receive the benefits of the nursing care activities. We have three types of cardiology patients: intensive care, intermediate care, and normal care. These patients make quite different demands on the nursing activities. For example, intensive care patients rarely have walking time but use a lot of treatments and need more monitoring time.

Exhibit 6-7

Activity Dictionary: Cardiology Unit

Activity Name	Activity Description	Activity Type	Cost Object(s)	Activity Driver
Supervising nurses	Scheduling, coordinating, and performance evaluation	Secondary	Activities within department	Percentage of time nurses spend on each activity
Treating patients	Administering medicine and changing dressings	Primary	Patient types	Number of treatments
Providing hygienic care	Bathing, changing bedding and clothes, walking patients	Primary	Patient types	Labour hours
Responding to patient requests	Answering calls, counselling, providing snacks, etc.	Primary	Patient types	Number of requests
Monitoring patients	Checking vital signs and posting patient information	Primary	Patient types	Monitoring hours

Activity Dictionary Based on the answers to the interview, an activity dictionary can now be prepared. Exhibit 6-7 illustrates the dictionary for the cardiology unit. The activity dictionary names the activity (typically by using an action verb and an object that receives the action), describes the tasks that make up the activity, classifies the activity as primary or secondary, lists the users (cost objects), and identifies a measure of activity output (activity driver). For example, the supervising activity is consumed by the following primary activities: treating patients, providing hygienic care, responding to patient requests, and monitoring patients. The three products—intensive care patients, intermediate care patients, and normal care patients—in turn, consume the primary activities.

Steps 2 and 3: Assign Costs to Activities

After identifying and describing activities, the next task is determining how much it costs to perform each activity. The cost of an activity is simply the cost of the resources consumed by each activity. Activities consume resources such as labour, materials, energy, and capital. The cost of these resources is found in the general ledger, but how much is spent on each activity is not revealed. Resource costs must be assigned to activities using direct and driver tracing. For example, consider the labour resource. The time spent on each activity is the driver used to assign the labour costs to the activity. If the time spent is 100 percent, then labour is exclusive to the activity, and direct tracing is the cost assignment method (such as the labour cost of nursing supervision). On the other hand, if the nursing resource is shared by several activities, then driver tracing is used for the cost assignment. These drivers are called resource drivers. **Resource drivers** are factors that measure the consumption of resources by activities. For labour resources, a *work distribution matrix* is often used. A work distribution matrix simply identifies the amount of labour consumed by each activity and is derived from the interview process (or a written survey). Interviews, survey forms, questionnaires, and timekeeping systems are examples of tools that can be used to collect data on resource drivers. Notice that tracking the effort spent on different activities is similar to tracking the time that

labourers spend on different jobs. However, there is one critical difference. The percent of effort spent on various activities is usually fairly constant and may only need to be measured periodically (perhaps annually). In effect, the labour time is a standard used to assign the cost of resources.

Labour is only one of many resources consumed by activities. Activities also consume materials, capital, and energy. The interview, for example, reveals that cardiology care activities also include the use of monitors (capital), a computer (capital), uniforms (materials), and supplies (materials). The cost of these other resources is also assigned to activities using direct tracing and resource drivers. Assigning costs to activities completes the first stage of activity-based costing. In this first stage, activities are classified as primary and secondary. If there are secondary activities, then intermediate stages exist. In an intermediate stage, the cost of secondary activities is assigned to those activities (or other intermediate cost objects) that consume their output. These calculations and concepts are illustrated in Cornerstone 6-6.

The assignment of resource costs to activities requires that the resource costs described in the general ledger be unbundled and reassigned. In a traditional accounting system, the general ledger reports costs by department and by spending account (based on a chart of accounts). The $340,000 of nursing salaries, for example, would be recorded as part of the total salaries of the cardiology unit. The general ledger indicates what is spent, but it does not reveal how the resources are spent. In an activity-based cost system, costs must be reported by activity. Thus, an ABC system must restate the general ledger costs so that the new system reveals how the resources are being consumed. Exhibit 6-8 illustrates the unbundling concept for nursing care activities in the cardiology unit. As the exhibit indicates, the reassignment of resource costs to individual activities contributes to the creation of an ABC database for the organization.

Step 4: Identify Cost Objects

Once the costs of primary activities are determined, these costs can then be assigned to products or other cost objects in proportion to their usage of the activity, as measured by activity drivers. However, before any assignment is made, the cost objects must be identified and the demands these objects place on the activities must be measured. Many different cost objects are possible: products, materials, customers, distribution channels, suppliers, and geographical regions are some examples. For our example, the cost objects are products (services): intensive cardiology care, intermediate cardiology care, and normal cardiology care. How to deal with cost assignment for other cost objects is discussed in a later section. **Activity drivers** measure the demands that cost objects place on activities. Most ABC system designs choose between one of two types of activity drivers: transaction drivers and duration drivers. **Transaction drivers** measure the number of times an activity is performed, such as the number of treatments and the number of requests. **Duration drivers** measure the demands in terms of the time it takes to perform an activity, such as hours of hygienic care and monitoring hours.

Exhibit 6-8

Unbundling of General Ledger Costs

General Ledger → ABC Database			
Cardiology Unit			
Chart of Accounts View		**ABC View**	
Supervision	$ 50,000	Supervising nurses	$ 60,000
Supplies and uniforms	60,000	Treating patients	98,500
Salaries	340,000	Providing hygienic care	78,800
Computer	10,000	Responding to requests	98,500
Monitor	26,000	Monitoring patients	150,200
Total	$486,000	Total	$486,000

The HOW and WHY of Assigning Resource Costs to Activities

CORNERSTONE 6-6

Information:

Resources		Activities	Nursing Hours	
Supervision	$ 50,000	Supervising nurses	2,000	10.0%
Supplies and uniforms	60,000	Treating patients	4,500	22.5
Salaries	340,000	Providing hygienic care	3,600	18.0
Computer	10,000	Responding to requests	4,500	22.5
Monitor	26,000	Monitoring patients	5,400	27.0
Total	$486,000	Total	20,000	100.0%
		Total without supervising	18,000	

- Monitors are used only by the monitoring activity.
- The one computer is used 800 hours for supervisory work (40 percent) and 1,200 hours for monitoring work (60 percent).
- The nursing resources (supplies, uniforms, and labour) are assigned to activities using nursing hours. The supervisor spends 100 percent of her time on supervision.

Why:

Activities consume resources, and other cost objects consume activities. The cost of each activity must therefore be determined. The cost of resources is assigned to activities using direct tracing and driver tracing. Resource drivers are used to assign shared resources. After this initial assignment, the costs of secondary activities are assigned to primary activities.

Required:

1. Prepare a work distribution matrix for the five activities.
2. Calculate the cost of each activity.
3. What if the cost of the supervising activity is assigned to the other four activities? Why would this be done? If it is done, what is the final cost of these four primary activities?

Solution:

1.

Percentage of Time on Each Activity			
Activity	**Supervisor**	**Nurses**	**Supporting Calculation**
Supervising nurses	100%	0%	(2,000/2,000)
Treating patients	0	25	(4,500/18,000)
Providing hygienic care	0	20	(3,600/18,000)
Responding to requests	0	25	(4,500/18,000)
Monitoring patients	0	30	(5,400/18,000)

CORNERSTONE 6-6 *(continued)*

2.

Activities	Monitor[a]	Computer[b]	Nursing Resources[c]	Total
Supervising nurses		$4,000	$ 56,000	$ 60,000
Treating patients			98,500	98,500
Providing hygienic care			78,800	78,800
Responding to requests			98,500	98,500
Monitoring patients	$26,000	6,000	118,200	150,200

[a] Exclusive use by monitoring (100% × $26,000)
[b] 0.40 × $10,000; 0.60 × $10,000
[c] $50,000 + (0.10 × $60,000); [(0.25 × $340,000) + (0.225 × $60,000)]; [(0.20 × $340,000) + (0.18 × $60,000)]; [(0.25 × $340,000) + (0.225 × $60,000)]; [(0.30 × $340,000) + (0.27 × $60,000)]

3. Supervising is a secondary activity, and its costs are consumed by primary activities (assigned in proportion to the labour content of each activity).

Treating patients	$113,500[a]
Providing hygienic care	90,800[b]
Responding to requests	113,500[c]
Monitoring patients	168,200[d]

[a] $98,500 + (0.25 × $60,000)
[b] $78,800 + (0.20 × $60,000)
[c] $98,500 + (0.25 × $60,000)
[d] $150,200 + (0.30 × $60,000)

Duration drivers should be used when the time required to perform an activity varies from transaction to transaction. If, for example, treatments for normal care patients average 10 minutes but for intensive care patients average 45 minutes, then treatment hours may be a much better measure of the demands placed on the activity of treating patients than the number of treatments.

With the drivers defined, a bill of activities can be created. A **bill of activities** specifies the product, expected product quantity, activities, and amount of each activity expected to be consumed by each product. Exhibit 6-9 presents a bill of activities for the cardiology care example.

Exhibit 6-9

Bill of Activities: Cardiology Unit

Activity	Driver	Normal	Intermediate	Intensive	Total
Production (output)	Patient days	10,000	5,000	3,000	
Treating patients	Treatments	500	1,000	1,500	3,000
Providing hygienic care	Hygienic hours	1,125	562	1,913	3,600
Responding to requests	Requests	3,000	4,000	1,000	8,000
Monitoring patients	Monitoring hours	540	1,620	3,240	5,400

Steps 5 and 6: Calculate Primary Activity Rates and Assign Them to Cost Objects

Primary activity rates are computed by dividing the budgeted activity costs by practical activity capacity, where activity capacity is the amount of activity output (as measured by the activity driver). Practical capacity is the activity output that can be produced if the activity is performed efficiently. Using data from Cornerstone 6-6 and Exhibit 6-9, the activity rates for the cardiology unit nursing care example can now be calculated:

Rate Calculations:

Treating patients:	$113,500/3,000 = $37.83 per treatment
Providing hygienic care:	$90,800/3,600 = $25.22 per hour of care
Responding to requests:	$113,500/8,000 = $14.19 per request
Monitoring patients:	$168,200/5,400 = $31.15 per monitoring hour

Note: Rates are rounded to the nearest cent.

These rates provide the price charged for activity usage. Using these rates, costs are assigned as shown in Exhibit 6-10. As should be evident, the assignment process is the same as that for the PlayFun example illustrated earlier in Cornerstone 6-5.

Unit-, Batch-, Product-, and Facility-Level Activities To help identify activity drivers and enhance the management of activities, activities are often classified into one of the following four general activity categories: (1) unit-level, (2) batch-level, (3) product-level, and (4) facility-level. **Unit-level activities** are those that are performed each time a unit is produced. Grinding, polishing, and assembly are examples of unit-level activities. **Batch-level activities** are those that are performed each time a batch is produced. The costs of batch-level activities vary with the number of batches but are fixed (and, therefore, independent) with respect to the number of units in each batch. Setups, inspections (if done by sampling units from a batch), purchasing, and materials handling are examples of batch-level activities. **Product-level activities** are those activities performed that enable the various products of a company to be produced. These activities and their costs tend to increase as the number of different products increases. Engineering changes (to products), developing product-testing procedures, introducing new

Exhibit 6-10

Assigning Costs: Final Cost Objects

	Normal	Intermediate	Intensive
Treating patients:			
$37.83 × 500	$ 18,915		
$37.83 × 1,000		$ 37,830	
$37.83 × 1,500			$ 56,745
Providing hygienic care:			
$25.22 × 1,125	28,373		
$25.22 × 562		14,174	
$25.22 × 1,913			48,246
Responding to requests:			
$14.19 × 3,000	42,570		
$14.19 × 4,000		56,760	
$14.19 × 1,000			14,190
Monitoring patients:			
$31.15 × 540	16,821		
$31.15 × 1,620		50,463	
$31.15 × 3,240			100,926
Total costs	$106,679	$159,227	$220,107
Units	÷10,000	÷5,000	÷3,000
Nursing cost per patient day*	$ 10.67	$ 31.85	$ 73.37

*Rounded to nearest cent.

products, and expediting goods are examples of product-level activities. **Facility-level activities** are those that sustain a factory's general manufacturing processes. Providing facilities, maintaining grounds, and providing plant security are examples.

Classifying activities into these general categories facilitates product costing because the costs of activities associated with the different levels respond to different types of activity drivers. (Cost behaviour differs by level.) Knowing the activity level is important because it helps management identify the activity drivers that measure the amount of each activity output being consumed by individual products. Activity-based costing systems improve product costing accuracy by recognizing that many of the so-called fixed overhead costs vary in proportion to changes other than production volume. Level classification also provides insights concerning the root causes of activities and thus can help managers in their efforts to improve activity performance.

By understanding what causes these costs to increase or decrease, they can be traced to individual products. This cause-and-effect relationship allows managers to improve product costing accuracy, which can significantly improve decision making. Additionally, this large pool of fixed overhead costs is no longer so mysterious. Knowing the underlying behaviour of many of these costs allows managers to exert more control over the activities that cause the costs. It also allows managers to identify which of the activities add value and which do not. Value analysis is the heart of activity-based management and is the basis for continuous improvement. Activity-based management and continuous improvement are explored in later chapters.

OBJECTIVE 4
Explain how ABC can be simplified.

Reducing the Size and Complexity of an ABC System

As should be evident from the discussion up to this point, ABC systems are expensive to create and implement, complex to operate, and difficult to modify or update. You may wish to review Exhibit 6-5, which listed the six steps for the process of creating, implementing, and operating an ABC system. The first three steps correspond to the first stage of ABC (Stage 1), and the last three steps correspond to the second stage of ABC (Stage 2). Stage 1 requires time-consuming and costly interviewing and surveying with the objective of identifying and classifying activities and then determining the cost of each activity. This Stage 1 process produces results that are subjective and difficult to validate. Stage 2 requires an activity rate for each activity. An organization may have hundreds of different activities and, thus, hundreds of activity rates. Activity rates require the identification of activity drivers that measure the consumption of activities by cost objects. Both Stage 1 and Stage 2 are complex and costly. Efforts to simplify ABC have been proposed that involve either before-the-fact simplification or after-the-fact simplification. One prominent before-the-fact simplification approach is *Time-Driven ABC (TDABC)* and is concerned with simplifying Stage 1. Two after-the-fact simplification approaches that simplify Stage 2 are the *Approximately Relevant ABC System* and the *Equally Accurate ABC System*.

Before-the-Fact Simplification: TDABC

Time-Driven Activity-Based Costing (TDABC) is a before-the-fact simplification method that simplifies Stage 1 by eliminating the need for detailed interviewing and surveying to determine resource drivers.[2] Activities still must be identified. However, TDABC assigns resource costs to activities in a very simple and straightforward way. First, it calculates the total operating cost of a department or process for supplying resource capacity (cost of all resources such as equipment, personnel, materials, etc.). Second, it calculates a capacity cost rate by dividing the total resource cost by the practical capacity (as measured by resource time used in the department) of the resources supplied:

$$\text{Capacity cost rate} = \text{Cost of resources supplied} / \text{Practical capacity of resources supplied}$$

[2] TDABC is described in Robert S. Kaplan and Steven R. Anderson, "Time-Driven Activity-Based Costing," *Harvard Business Review* (November 2004): 131–138; "The Innovation of Time-Driven Activity-Based Costing," *Cost Management* 21, 2 (March/April): 5–15.

Third, it estimates the time to perform one unit of activity. One unit of activity is one unit of an activity driver; thus, multiplying the capacity cost rate by the time to perform one unit of activity and then by the total activity output (as measured by the activity driver) yields the activity cost:

$$\begin{aligned}\text{Activity cost} &= \text{Capacity cost rate} \times \text{Time to perform one unit of activity} \\ &\quad \times \text{Total activity output} \\ &= \text{Activity rate} \times \text{Total activity output}\end{aligned}$$

In practical terms, the resource cost can be driven directly to products without formally calculating the activity cost. Since by multiplying the capacity cost rate by the time it takes to perform one unit of activity yields the activity rate, resource costs can be assigned to individual products by simply multiplying the activity rate by the amount of activity consumed by each product. Cornerstone 6-7 illustrates the basic concepts of TDABC.

TDABC Features

Easy-to-Update Requirements Cornerstone 6-7 illustrates that the detailed requirements typically found in Stage 2 are not needed. Cornerstone 6-7 also shows that TDABC has a significant advantage when it comes to updating requirements. If new activities are added or identified, there is no need to engage in detailed interviews as with traditional ABC. Instead, all that is needed is observation to determine how long it takes to produce one unit of output for each new activity. Other changes in operations such as changes in resource costs or time (e.g., resource price increases, acquisition of new equipment, process improvements, increase in activity efficiency, etc.) are easily updated by adjusting the capacity cost rate. This then produces new activity rates. Updates are easily obtained as changes occur.

Cost of Unused Capacity Although not discussed in Cornerstone 6-7, another feature of TDABC is its ability to calculate the cost of unused capacity. The unit time multiplied by the activity output is the total time used by an activity. If the actual activity quantities differ from the practical capacity quantities (practical capacity ranges from 80–90 percent of theoretical capacity), then the cost assigned to products will be less than the cost of the total resources. The difference is the cost of unused capacity.

$$\text{Cost of unused capacity} = \text{Total cost of resources} - \text{Total resource cost assigned to products}$$

For example, if the total cost of resources is $486,000 and the total cost of resources assigned to products is $476,000, then the cost of unused capacity is $10,000 ($486,000 − $476,000).

Response Time Occasionally, the time to process a transaction driver, such as response to requests, may differ depending on the category of the patient treated. For example, suppose that it takes 0.4 hour to respond to normal-care patient requests; however, an additional 0.3 hour is needed to respond to critical-care patient requests and an additional 0.8 hour is needed to respond to emergency-state patient requests. In a traditional ABC system, this complexity can be handled by creating three different activities. TDABC, on the other hand, handles this increased complexity in a very simple, straightforward way. TDABC estimates the resource demand using a time equation:

$$\begin{aligned}\text{Response time} = {} & 0.40 + 0.30 \text{ (if critical patient)} + \\ & 0.80 \text{ (if emergency-state patient)}\end{aligned}$$

Suppose that the capacity cost rate is $30 per hour. The cost per response for a normal patient is $30 × 0.4 = $12. For a critical care patient, the cost per response is $30(0.40 + 0.30) = $21 and for an emergency-state patient it is $30(0.40 + 0.80) = $36. The time equation allows different response times to be calculated depending on the category of patient and thus different costs can be assigned to the different request categories.

CORNERSTONE 6-7

The HOW and WHY of TDABC

Information:

Exhibit 6-9 and the following information on a cardiology unit:

Resources		Activities	Time/Unit of Activity
Supervision	$ 50,000	Treating patients	1.40 hrs
Supplies and uniforms	60,000	Providing hygienic care	1.00 hr
Salaries	340,000	Responding to requests	0.60 hr
Computer	10,000	Monitoring patients	1.00 hr
Monitor	26,000		
Total	$486,000		
Total nursing hours	18,000	(practical capacity)	

Why:

TDABC avoids detailed interviewing, surveying, and timekeeping systems required for assessing resource drivers to assign resource costs to activities. All that is needed is the total labour time in a department or process (measured at practical capacity), the total resource costs, and the time required to perform one activity. The first two data items are readily obtained through objective estimates. The time to perform one unit of activity is simply the unit of time for a duration driver. For transaction drivers, the amount of time required to perform one transaction (such as a setup) is obtained by observation or interview. The capacity cost rate is total resource cost/total time at practical capacity. This rate is multiplied by the time per unit of an activity to obtain the activity rate. This rate multiplied by the total activity output provides the activity cost.

Required:

1. Calculate the capacity cost rate for the cardiology unit.
2. Calculate the activity rate for each activity and the cost of the two activities: Treating patients and Monitoring patients.
3. ***What if*** at mid-year, the nursing supervisor resigns and a new supervisor is hired for a salary of $63,200 and the cardiology nurses also receive a 12 percent increase in salaries? Update the activity rates calculated in Requirement 2.

Solution:

1. Capacity cost rate = $486,000/18,000 = $27 per hour

2. Treating patients: $27 × 1.40 = $37.80 per patient
   Providing hygienic care: $27 × 1 = $27 per care hour
   Responding to requests: $27 × 0.60 = $16.20 per request
   Monitoring patients: $27 × 1 = $27 per monitoring hour
   Treating patients: $37.80 × 3,000 = $113,400
   Monitoring patients: $27 × 5,400 = $145,800

3. New capacity cost rate = $540,000/18,000 = $30 (Resource costs increase by $54,000 due to salary changes of the supervisor and nurses.) New activity rates are therefore:

Treating patients: $30 × 1.40 = $42 per patient
Providing hygienic care: $30 × 1 = $30 per care hour
Responding to requests: $30 × 0.60 = $18 per request
Monitoring patients: $30 × 1 = $30 per monitoring hour

CORNERSTONE 6-7 *(continued)*

An interesting application of time equations is reported for the inter-library loan service of the **KULeuven Arenberg Library**.[3] The initial activity for a requested book or article from another library is defined as *processing the request*. The transaction driver is defined as the number of requests processed. Thus, TDABC must estimate the time required to process one request. The estimated time required to process one request is 6.8 minutes and is the sum of the following tasks: receive the request, select the library that has the requested book or article, print a hard copy of the request, enter data in an Excel™ file, and classify all printouts. The time for processing a request can be increased or decreased depending on two additional complexities. First, if the library patron asks for feedback, then an additional 6.3 minutes are required to provide the feedback via e-mail, telephone, or personal contact at the library desk. Second, the lending library may respond negatively and indicate that the book or article is not available. In this case, the process needs to be repeated with a new potential lending library, which adds an additional 6.6 minutes. The resulting time equation for this initial activity is given as:

Process time = 6.8 + 6.3 (if feedback is requested) + 6.6 (if negative response)

After-the-Fact Simplification

Although TDABC simplifies Stage I, Stage 2 still has to deal with hundreds of different activity rates. While information technology is capable of handling this volume, there is merit to reducing the number of rates if it can be done without suffering a significant decrease in the accuracy of the cost assignments. Fewer activity rates may produce more readable and manageable product cost reports, reducing the perceived complexity of an activity-based costing system and increasing its likelihood of managerial acceptance. For example, if there are a large number of activities on a bill of activities, managers are likely to find it too complex to read, interpret, and use. In this case, the more complex ABC or TDABC system may not be sustained. One of the oft-cited reasons for refusing to implement an ABC system, or for abandoning it once implemented, is the perceived complexity of the system. Fewer rates may also reduce the ongoing cost of operating an ABC system. Predetermined rates require that actual activity data be collected so that overhead can be applied. Fewer rates thus reduce the ongoing data collection activity required. In practical terms, a complex ABC system may not be sustainable simply because there is too much actual driver data to collect effectively.

Consider the data presented in Exhibit 6-11 for Patna Company, a manufacturer of wafers for integrated circuits. Patna produces two types of wafers: Wafer A and Wafer B. A wafer is a thin slice of silicon used as a base for integrated circuits or other electronic components. The dies on each wafer represent a particular configuration—a configuration designed for use by a particular end product. Patna produces wafers in batches, where each batch corresponds to a particular type of wafer (A or B). In the wafer inserting and sorting process, dies are inserted, and the wafers are tested to ensure that the dies are not defective. From Exhibit 6-11, we see that the activity-based costs for Wafer A and Wafer B are $800,000 and $1,200,000, respectively. These activity-based costs are calculated using the 12 drivers. A key question is whether or not the benefits of an ABC system can essentially

[3] Eli Pernot, Filip Roodhooft, and Alexandria Van den Abbeele, "Time-Driven Activity-Based Costing for Inter-Library Services: A Case Study in a University," *The Journal of Academic Libraryship* 33, 5 (September 2007): 551–560.

Exhibit 6-11

Data for Patna Company

Activity	Budgeted Activity Cost	Driver	Quantity[a]	Expected Consumption Ratios: Wafer A	Expected Consumption Ratios: Wafer B
Inserting and sorting process:					
1. Developing test programs	$ 400,000	Engineering hours	10,000	0.25	0.75
2. Making probe cards	58,750	Development hours	4,000	0.10	0.90
3. Testing products	300,000	Test hours	20,000	0.60	0.40
4. Setting up batches	40,000	Number of batches	100	0.55	0.45
5. Engineering design	80,000	Number of change orders	50	0.15	0.85
6. Handling wafer lots	90,000	Number of moves	200	0.45	0.55
7. Inserting dies	350,000	Number of dies	2,000,000	0.70	0.30
Procurement process:					
8. Purchasing materials	450,000	Number of purchase orders	2,500	0.20	0.80
9. Unloading materials	60,000	Number of receiving orders	3,000	0.35	0.65
10. Inspecting materials	75,000	Inspection hours	5,000	0.65	0.35
11. Moving materials	30,000	Distance moved	3,000	0.50	0.50
12. Paying suppliers	66,250	Number of invoices	3,500	0.30	0.70
Total activity cost	$2,000,000				
Unit-level (plantwide) cost assignment[b]				$1,400,000	$600,000
Activity cost assignment[c]				$800,000	$1,200,000

[a] Total amount of the activity expected to be used by both products
[b] Calculated using *number of dies* as the single unit-level driver:
Wafer A = 0.7 × $2,000,000; Wafer B = 0.3 × $2,000,000
[c] Calculated using *each* activity cost and either the associated consumption ratios or activity rates. For example, the cost assigned to Wafer A using the consumption ratio for *developing testing programs* is 0.25 × $400,000 = $100,000. Repeating this for each activity and summing yields a total of $800,000 assigned to Wafer A.

be captured with a system using a significantly reduced number of drivers. We will consider two approaches for simplification: (1) Approximately Relevant ABC Systems and (2) Equally Accurate Reduced ABC Systems.

Approximately Relevant ABC Systems It is possible that an organization is better off having an approximately relevant ABC system rather than a precisely useless one.[4] One intriguing suggestion for obtaining an approximately relevant ABC system is to do an analysis of the activity accounting system and to use only the most expensive activities for ABC assignment.[5] The costs of all other activities can be added to the cost pools of the expensive activities. For example, the costs of the less expensive activities could be allocated in proportion to the costs in each of the expensive activities. In this way, most costs will be assigned to the products accurately. The costs of the most expensive activities will still be assigned using appropriate cause-and-effect drivers, while the added costs will be assigned somewhat arbitrarily. The advantages of this approach are that it is simple, easy to understand, and easy to implement. It also often provides a good approximation of the ABC costs. Cornerstone 6-8 illustrates this approach.

Cornerstone 6-8 illustrates that the ABC costs are approximated quite well by the reduced system of four drivers. Furthermore, it seems that the cost is much better than the plantwide rate, even when the system has significant error relative to the ABC assignments. If activity costs roughly follow the Pareto principle or 80/20 rule (80 percent of the overhead costs are caused by 20 percent of the activities), then this approach for

[4] Tom Pryor, "Simplify Your ABC," *Cost Management Newsletter* 15 (June 2004): accessed online at http://www.icms.net/news-21.htm.
[5] Ibid.

The HOW and WHY of Approximately Relevant ABC Systems

CORNERSTONE 6-8

Information:
Exhibit 6-11.

Why:
The number of drivers used to assign costs can be reduced by using only the drivers associated with the most expensive activities. Costs of the less expensive activities are allocated to the more expensive activities in proportion to their original cost. This provides a cost system that assigns most of the costs using causal relationships and yet is simple to understand and easy to use. For this method to be of value, a high percentage of the overhead costs must be attributable to a relatively small number of activities.

Required:
1. Using the four most expensive activities, calculate the overhead cost assigned to each product.
2. Calculate the error relative to the fully specified ABC product cost and comment on the outcome.
3. ***What if*** activities 1, 5, 8, and 12 each had a cost of $400,000 and the remaining activities had a cost of $50,000? Calculate the cost assigned to Wafer A by a fully specified ABC system and then by an approximately relevant ABC approach. Comment on the implications for the approximately relevant approach.

Solution:
1.

Activity	Budgeted Activity Cost[a]	Driver	Quantity	Expected Consumption Ratios: Wafer A	Expected Consumption Ratios: Wafer B
1. Developing test programs	$ 533,333	Engineering hours	10,000	0.25	0.75
3. Testing products	400,000	Test hours	20,000	0.60	0.40
7. Inserting dies	466,667	Number of dies	2,000,000	0.70	0.30
8. Purchasing materials	600,000	Purchase orders	2,500	0.20	0.80
Total activity cost	$2,000,000				
Approximate ABC cost[b]				$820,000	$1,180,000

[a] Original activity cost plus share of the costs of the remaining "inexpensive" activities (allocated in proportion to the original costs of the expensive activities (as shown in Exhibit 6-11): For example, the cost pool for purchasing materials is $450,000 + [($450,000/$1,500,000) × $500,000] = $600,000.
[b] Reduced system ABC assignment (using consumption ratios): Wafer A: [(0.25 × $533,333) + (0.60 × $400,000) + (0.70 × $466,667) + (0.20 × $600,000)]; Wafer B: [(0.75 × $533,333) + (0.40 × $400,000) + (0.30 × $466,667) + (0.80 × $600,000)]

2. Relative error, Wafer A: ($820,000 − $800,000)/$800,000 = 0.025 (2.5%)
Relative error, Wafer B: ($1,180,000 − $1,200,000)/$1,200,000 = −0.017 (−1.7%)

   The maximum error is a 2.5 percent overstatement of the ABC cost of Exhibit 6-11, when 12 drivers are used. This is a very good approximation indicating that the approach has merit.

3. Using consumption ratios, the ABC cost of Wafer A is $400,000(0.25 + 0.15 + 0.20 + 0.30) + $50,000(0.10 + 0.60 + 0.55 + 0.45 + 0.70 + 0.35 + 0.65 + 0.50) = $555,000. Since the cost is the same for each of the four

CORNERSTONE 6-8 *(continued)*

most expensive activities, the reassigned cost for each of the four activities is $500,000 (each receives the same amount of the less expensive activities). Thus, using consumption ratios, the approximately relevant cost is $500,000(0.25 + 0.15 + 0.20 + 0.30) = $450,000. The difference between the ABC cost and the approximately relevant cost is −$105,000 ($450,000 − $555,000) or a relative error of about −19 percent. It appears that a significant error can occur even when the expensive activities account for about 80 percent of the total overhead. However, this is still a vast improvement over the plantwide rate assignment (which is $1,400,000 vs. $555,000).

reducing the size of the system has considerable promise. For example, if a system has 100 activities, then the top 20 activities (as measured by their cost) need to account for a very high percentage of the total costs. In those cases where this holds, a reduced system may work reasonably well because *most* of the costs are assigned using cause-and-effect relationships. Even so, there may be some who would balk at the notion of using 15 to 20 drivers. The approach also loses its usefulness for those companies where a small number of activities do not account for a large share of the overhead costs.

Equally Accurate Reduced ABC Systems Another approach is to use expected consumption ratios to reduce the number of drivers. Although the theoretical motivation for this approach is beyond the scope of the text, the methodology is straightforward. Consider again the 12 activities of Exhibit 6-11. The product costs assigned to Wafer A and Wafer B were $800,000 and $1,200,000, respectively. Thus, Wafer A is expected to consume 40 percent ($800,000/$2,000,000) of the total cost being assigned, and Wafer B is expected to consume 60 percent ($1,200,000/$2,000,000) of the total cost being assigned. Wafer A has an *expected global consumption ratio* of 0.40, and Wafer B has an *expected global consumption ratio* of 0.60. The **expected global consumption ratio** is the proportion of the total activity costs consumed by a given product (cost object). The expected global consumption ratio pattern for Patna Company is (0.40, 0.60). Each activity also has a consumption ratio pattern.

For a two-product firm, the activity consumption ratio patterns are always described by an array (vector) of two components. For the Patna Company example, the first ratio in the array is the proportion of the activity consumed by Wafer A, and the second ratio is the proportion consumed by Wafer B. For example, the activity, developing test programs, has a consumption pattern of (0.25, 0.75), where Wafer A consumes 25 percent of the activity cost and Wafer B consumes 75 percent of the activity cost. Similarly, the activity, inserting dies, has a consumption pattern of (0.70, 0.30), where Wafer A consumes 70 percent of the activity cost and Wafer B consumes 30 percent. As the number of products increases, the number of consumption ratio components also increases. The dimension of the consumption ratio pattern array corresponds to the number of products. When the number of activities is more than the number of products, it is always possible to find a reduced system that *duplicates* the cost assignments of the larger system. To achieve this duplication, the number of drivers needed is *at most* equal to the number of products (two drivers for our example). Thus, two drivers can be used to match the larger 12-driver system cost assignments. A key step in the reduction process is expressing each global consumption ratio as a weighted combination of the consumption ratios for each product. For example, using the activities, developing test programs and inserting dies, the weighted combination for Wafer A is $0.25w_1 + 0.70w_2 = 0.40$. A similar equation can be developed for Wafer B: $0.75w_1 + 0.30w_2 = 0.60$. Solving these two equations yields values for w_1 and w_2. These values are *allocation ratios* and when multiplied by the total overhead costs define two cost pools (one for the first activity and one for the second activity). Using the consumption ratios or drivers for each activity then assigns the appropriate amount of cost to each product. How this is achieved and the motivation are summarized in Cornerstone 6-9.

The HOW and WHY of Equally Accurate Reduced ABC Systems

CORNERSTONE 6-9

Information:

From Exhibit 6-11, the following data are extracted:

			Expected Consumption Ratios	
Activity	**Driver**	**Quantity**	**Wafer A**	**Wafer B**
3. Testing products	Test hours	20,000	0.60	0.40
8. Purchasing materials	Purchase orders	2,500	0.20	0.80
1. Developing test programs	Engineering hours	10,000	0.25	0.75
7. Inserting dies	Number of dies	2,000,000	0.70	0.30
ABC assignment			$800,000	$1,200,000
Total overhead cost			$2,000,000	

Why:

It is always possible to find a reduced system that matches the accuracy of the larger ABC system. Using fewer drivers facilitates acceptance and use of an ABC system. The steps that should be followed to achieve the desired simplification are: (1) Calculate the expected global consumption ratio (ABC product cost/total overhead cost); (2) Select the needed number of activities (equal to the number of products); (3) Form equations for each product by multiplying the consumption ratios of each product by the allocation weights and setting the result equal to the product's global consumption ratio; (4) Solve the simultaneous set of equations; (5) Use the weights to form the cost pools that will duplicate the larger ABC system cost assignments; and (6) Use the consumption ratios (or drivers) to assign the cost pools to individual products.

Required:

1. Form reduced system cost pools for activities 3 and 8.
2. Assign the costs of the reduced system cost pools to Wafer A and Wafer B.
3. ***What if*** the two activities were 1 and 7? Repeat Requirements 1 and 2. What does this imply?

Solution:

1. Global ratios = 0.40 ($800,000/$2,000,000) for Wafer A and 0.60 ($1,200,000/$2,000,000) for Wafer B.
   Equations:

   $0.60w_1 + 0.20w_2 = 0.40$ (Wafer A)

   $0.40w_1 + 0.80w_2 = 0.60$ (Wafer B)

   Multiplying both sides of the first equation by 4, subtracting the second from the first, and solving, we obtain:

   Solving: $w_1 = 1/2$ and $w_2 = 1/2$

   Testing products cost pool: $0.5 \times \$2{,}000{,}000 = \$1{,}000{,}000$

   Purchasing cost pool: $0.5 \times \$2{,}000{,}000 = \$1{,}000{,}000$

CORNERSTONE 6-9 *(continued)*

2. Using the consumption ratios, the same cost assignment is realized with two drivers:
   Wafer A: $(0.60 \times \$1{,}000{,}000) + (0.20 \times \$1{,}000{,}000) = \$800{,}000$
   Wafer B: $(0.40 \times \$1{,}000{,}000) + (0.80 \times \$1{,}000{,}000) = \$1{,}200{,}000$
3. Equations:
   $0.25w_1 + 0.70w_2 = 0.40$ (Wafer A)
   $0.75w_1 + 0.30w_2 = 0.60$ (Wafer B)
   Solving: $w_1 = 2/3$ and $w_2 = 1/3$
   Cost pool (test programs): $(2/3) \times \$2{,}000{,}000 = \$1{,}333{,}333$
   Cost pool (inserting dies): $(1/3) \times \$2{,}000{,}000 = \$666{,}667$
   Wafer A: $(0.25 \times \$1{,}333{,}333) + (0.70 \times \$666{,}667) = \$800{,}000$ (rounded)
   Wafer B: $(0.75 \times \$1{,}333{,}333) + (0.30 \times \$666{,}667) = \$1{,}200{,}000$ (rounded)
   The implication is that any two activities will work—but negative allocations may occur if the global ratio on the right-hand side does not lie between the coefficients of the two allocation weights.

Cornerstone 6-9 shows that an equally accurate simplified system can be derived from the more complex ABC system. Instead of using 12 drivers, it is possible to use only two drivers and achieve the same cost assignment of the more complex system. This reduced system represents an *after-the-fact* simplification. The reduced system is derived from an *existing* complex ABC data set. Of course, the same is true for the approximately relevant reduced system that uses the Pareto principle to achieve the reduction. The value of after-the-fact simplification is based on two key justifications. First, the reduced system eliminates the perceived complexity of the system. For example, it is much easier for nonfinancial users to read, interpret, and use a two-driver system compared to a 12-driver system. Second, the reduced ABC system needs to collect actual driver data only for the drivers being used to assign the costs to products. For example, in the case of Patna Company, only actual data for testing hours and number of purchase orders need to be collected so that overhead costs can be assigned (applied) to the two products. This is much less costly than collecting actual data for 12 drivers. Finally, it should also be pointed out that the two drivers in Exhibit 6-11 are only one of many two-driver combinations that can be used to reduce the ABC system without sacrificing the assignment accuracy of the more complex system.

Summary of Learning Objectives

1. Describe the basics of plantwide and departmental overhead costing.

- Budgeted overhead costs are accumulated into plantwide or departmental pools and predetermined overhead rates are calculated.
- Predetermined rates use unit-level drivers such as direct labour hours and machine hours.
- Overhead is assigned by multiplying the rate by the actual total amount of unit-level driver (e.g., direct labour hours).

- The difference between the actual overhead and applied overhead is an overhead variance and is either under- or overapplied. If the variance is immaterial, it is closed to Cost of Goods Sold; otherwise, it is allocated among work-in-process inventory, finished goods, and cost of good sold.

2. Explain why plantwide and departmental overhead costing may not be accurate.

- Overhead assignments should reflect the amount of overhead demanded (consumed) by each product.
- Many overhead activities are unrelated to the units produced, and assigning overhead using unit-level drivers may distort product costs.
- If overhead is a significant proportion of total manufacturing costs, this distortion can be serious.
- Activity-based costing uses both unit-level and non-unit-level drivers and thus reflects a more accurate picture of the actual overhead consumed by products.

3. Provide a detailed description of activity-based product costing.

- Identify, define, and classify activities.
- Assign the cost of resources to each activity.
- Assign the cost of secondary activities to primary activities.
- Identify cost objects and specify the amount of each activity consumed by each cost object.
- Calculate primary activity rates.
- Assign activity costs to cost objects.

4. Explain how ABC can be simplified.

- TDABC, a before-the-fact simplification approach, eliminates the need to identify resource drivers to assign resource costs to activities, eliminating the need for much of the detailed implementation interviews.
- TDABC also makes it easier to update ABC when changes occur.
- Simplified ABC systems can be derived from complex ABC systems.
- Simplified systems facilitate the presentation and use of ABC information and reduce the cost of collecting actual driver data.
- Two after-the-fact approaches were discussed: the approximately relevant ABC system and the equally accurate reduced ABC system. The first approach may be useful for those firms where a few activities account for most of the overhead costs. The second system is useful whenever the number of activities is greater than the number of products (which is usually the case).

CORNERSTONES FOR CHAPTER 6

Review Problem

Unit-Based Costing versus Activity-Based Costing

Abat-Jour Lamp Company is noted for its full line of quality lamps. The company operates one of its plants in Montreal, Quebec. That plant produces two types of lamps: classical and modern. Jane Martinez, president of the company, recently decided to change from a unit-based, traditional costing system to an activity-based costing system. Before making the change companywide, she wanted to assess the effect on the product costs of the Montreal plant. This plant was chosen because it produces only two types of lamps; most other plants produce at least a dozen.

To assess the effect of the change, the following data have been gathered (for simplicity, assume one process):

Lamp	Quantity	Prime Costs	Machine Hours	Material Moves	Setups
Classical	400,000	$800,000	81,250	300,000	100
Modern	100,000	$150,000	43,750	100,000	50
Dollar amount	—	$950,000	$500,000*	$900,000	$600,000

*The cost of operating the production equipment.

Under the current system, the costs of operating equipment, materials handling, and setups are assigned to the lamps on the basis of machine hours. Lamps are produced and moved in batches.

Required:

1. Compute the unit cost of each lamp using the current unit-based approach.
2. Compute the unit cost of each lamp using an activity-based costing approach.
3. Show how a reduced system using two cost pools and two drivers, moves and setups, can be used to achieve the same cost assignments obtained in Requirement 2.

Solution:

1. Total overhead is $2,000,000. The plantwide rate is $16 per machine hour ($2,000,000/125,000). Overhead is assigned as follows:

$$\text{Classical lamps: } \$16 \times 81{,}250 = \$1{,}300{,}000$$
$$\text{Modern lamps: } \$16 \times 43{,}750 = \$700{,}000$$

The unit costs for the two products are as follows:

$$\text{Classical lamps: } (\$800{,}000 + \$1{,}300{,}000)/400{,}000 = \$5.25$$
$$\text{Modern lamps: } (\$150{,}000 + \$700{,}000)/100{,}000 = \$8.50$$

2. In the activity-based approach, a rate is calculated for each activity:

$$\text{Machining: } \$500{,}000/125{,}000 = \$4.00 \text{ per machine hour}$$
$$\text{Moving materials: } \$900{,}000/400{,}000 = \$2.25 \text{ per move}$$
$$\text{Setting up: } \$600{,}000/150 = \$4{,}000 \text{ per setup}$$

Overhead is assigned as follows:

Classical lamps:	
$4 × 81,250	$ 325,000
$2.25 × 300,000	675,000
$4,000 × 100	400,000
Total	$1,400,000

Modern lamps:	
$4 × 43,750	$ 175,000
$2.25 × 100,000	225,000
$4,000 × 50	200,000
Total	$ 600,000

This produces the following unit costs:

Classical lamps:	
Prime costs	$ 800,000
Overhead costs	1,400,000
Total costs	$2,200,000
Units produced	÷ 400,000
Unit cost	$ 5.50
Modern lamps:	
Prime costs	$ 150,000
Overhead costs	600,000
Total costs	$ 750,000
Units produced	÷ 100,000
Unit cost	$ 7.50

3. First, calculate the activity consumption ratios:

	Moving	Setups
Classical	300,000/400,000 = 3/4	100/150 = 2/3
Modern	100,000/400,000 = 1/4	50/150 = 1/3

Second, calculate the global consumption ratios (information from Requirement 2 is needed):

ABC Assignments		Global Ratios
Overhead assigned to classical:	$1,400,000	$1,400,000/$2,000,000 = 0.70
Overhead assigned to modern:	600,000	$600,000/$2,000,000 = 0.30
Total	$2,000,000	

Third, set up and solve the consumption ratio equations:

$$(3/4)w_1 + (2/3)w_2 = 0.70$$
$$(1/4)w_1 + (1/3)w_2 = 0.30$$

Solving, we have the allocation ratios: $w_1 = 0.40$ and $w_2 = 0.60$. Thus, the cost pools for the two activities are:

Moving: 0.40 × $2,000,000 = $800,000
Setups: 0.60 × $2,000,000 = $1,200,000

The activity rates for the reduced system would be:

Moving: $800,000/400,000 = $2.00 per move
Setups: $1,200,000/150 = $8,000 per setup

Overhead cost assignments:

Classical lamps:	
$2.00 × 300,000	$ 600,000
$8,000 × 100	800,000
Total	$1,400,000
Modern lamps:	
$2.00 × 100,000	$ 200,000
$8,000 × 50	400,000
Total	$ 600,000

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Discussion Questions

1. What is a predetermined overhead rate? Explain why it is used.
2. Describe what is meant by under- and overapplied overhead.
3. Explain how a plantwide overhead rate, using a unit-based driver, can produce distorted product costs. In your answer, identify two major factors that impair the ability of plantwide rates to assign cost accurately.
4. What are non-unit-related overhead activities? Non-unit-based cost drivers? Give some examples.
5. What is an overhead consumption ratio?
6. Overhead costs are the source of product cost distortions. Do you agree or disagree? Explain.
7. What is activity-based product costing?
8. What are the six steps that define the design of an activity-based costing system?
9. Explain how the cost of resources is assigned to activities. What is meant by the phrase "unbundling the general ledger accounts"?
10. What is a bill of activities?
11. Identify and define two types of activity drivers.
12. What are unit-level activities? Batch-level activities? Product-level activities? Facility-level activities?
13. How does TDABC simplify ABC?
14. Explain why it is easy to update a TDABC model.
15. Describe two ways to reduce a complex ABC system. Of the two ways, which has the most merit?

Cornerstone Exercises

OBJECTIVE 1
CORNERSTONE 6-1

Cornerstone Exercise 6-1 APPLIED OVERHEAD AND UNIT OVERHEAD COST: PLANTWIDE RATES

Liang Inc. produces two types of speakers: deluxe and regular. Liang uses a plantwide rate based on direct labour hours to assign its overhead costs. The company has the following estimated and actual data for the coming year:

Estimated overhead	$750,000
Expected activity	25,000
Actual activity (direct labour hours):	
Deluxe speaker	5,000
Regular speaker	20,000
Units produced:	
Deluxe speaker	10,000
Regular speaker	100,000

Required:

1. Calculate the predetermined plantwide overhead rate and the applied overhead for each product, using direct labour hours.
2. Calculate the overhead cost per unit for each product.
3. ***What if*** the deluxe product used 10,000 hours (to produce 10,000 units) instead of 5,000 hours (total expected hours remain the same)? Calculate the effect on the profitability of this product line if all 10,000 units are sold, and then discuss the implications of this outcome.

Cornerstone Exercise 6-2 OVERHEAD VARIANCES AND THEIR DISPOSAL

OBJECTIVE 1
CORNERSTONE 6-2

Aphrodite Company has the following data for the past year:

Actual overhead	$ 960,000
Applied overhead:	
Work-in-process inventory	$ 150,000
Finished goods inventory	250,000
Cost of goods sold	600,000
Total	$1,000,000

Aphrodite uses the overhead control account to accumulate both actual and applied overhead.

Required:

1. Calculate the overhead variance for the year and close it to Cost of Goods Sold.
2. Assume the variance calculated is material. After prorating, close the variances to the appropriate accounts and provide the final ending balances of these accounts.
3. ***What if*** the variance is of the opposite sign calculated in Requirement 1? Provide the appropriate adjusting journal entries for Requirements 1 and 2.

Cornerstone Exercise 6-3 DEPARTMENTAL OVERHEAD RATES

OBJECTIVE 1
CORNERSTONE 6-3

Fleming Inc. provided the following data for its two producing departments:

	Polishing	Painting	Total
Estimated overhead	$500,000	$100,000	$600,000
Direct labour hours (expected and actual):			
Frame A	2,000	5,000	7,000
Frame B	3,000	15,000	18,000
Total	5,000	20,000	25,000
Machine hours:			
Frame A	7,000	3,000	10,000
Frame B	3,000	2,000	5,000
Total	10,000	5,000	15,000

Machine hours are used to assign the overhead of the Polishing Department, and direct labour hours are used to assign the overhead of the Painting Department. There are 60,000 units of Frame A produced and sold and 100,000 of Frame B.

Required:

1. Calculate the overhead rates for each department.
2. Using departmental rates, assign overhead to the two products and calculate the overhead cost per unit. How does this compare with the plantwide rate unit cost, using direct labour hours?
3. ***What if*** the machine hours in Polishing were 2,000 for Frame A and 8,000 for Frame B and the direct labour hours used in Painting were 14,000 and 6,000, respectively? Calculate the overhead cost per unit for each product using departmental rates, and compare with the plantwide rate unit costs calculated in Requirement 2. What can you conclude from this outcome?

OBJECTIVE 2

CORNERSTONE 6-4

Cornerstone Exercise 6-4 CONSUMPTION RATIOS

Larissa Inc. produces two types of electronic parts and has provided the following data:

	Part X12	Part YK7	Total
Units produced	100,000	600,000	—
Direct labour hours	30,000	70,000	100,000
Machine hours	50,000	300,000	350,000
Number of setups	40	80	120
Testing hours	1,000	9,000	10,000
Number of purchase orders	500	3,500	4,000

There are four activities: machining, setting up, testing, and purchasing.

Required:

1. Calculate the activity consumption ratios for each product.
2. Calculate the consumption ratios for a plantwide (direct labour hours) rate. When compared with the activity ratios, what can you say about the relative accuracy of a plantwide rate? Which product is undercosted?
3. ***What if*** the machine hours were used for the plantwide rate? Would this remove the cost distortion of a plantwide rate?

OBJECTIVE 2

CORNERSTONE 6-5

Cornerstone Exercise 6-5 ACTIVITY-BASED PRODUCT COSTING

Kim Company produces two lawn mowers: basic and self-propelled. The company has four activities: machining, engineering, receiving, and packing. Information on these activities and their drivers is given below.

	Basic	Self-Propelled	Total
Units produced	250,000	750,000	—
Prime costs	$20,000,000	$75,000,000	$95,000,000
Machine hours	250,000	1,250,000	1,500,000
Engineering hours	1,000	9,000	10,000
Receiving orders	1,000	3,000	4,000
Inspection hours	2,000	4,000	6,000

Overhead costs:

Machining	$15,000,000
Engineering	5,000,000
Receiving	1,400,000
Inspecting products	900,000

Required:

1. Calculate the four activity rates.
2. Calculate the unit costs using activity rates. Also, calculate the overhead cost per unit.
3. ***What if*** consumption ratios were used to assign costs instead of activity rates? Show the cost assignment for the inspection activity.

Cornerstone Exercise 6-6 ASSIGNING COST OF RESOURCES TO ACTIVITIES, UNBUNDLING THE GENERAL LEDGER

OBJECTIVE 3
CORNERSTONE 6-6
SERVICE

Perlman Bank provided the following data about its resources and activities for its chequing account process:

Resources		Activities	Clerical Hours
Supervision	$ 70,000	Processing accounts	10,000
Phone and supplies	90,000	Issuing statements	5,000
Salaries	275,000	Processing transactions	7,000
Computer	25,000	Answering customer inquiries	3,000
Total	$460,000	Total	25,000

- Computers are used only by the issuing (30 percent) and processing transaction (70 percent) activities.
- Phone and supplies are 60 percent customer inquiries with the other 40 percent divided equally among the remaining activities, including supervising the chequing operation.
- The supervisor spends 100 percent of her time on supervision. In addition to the 25,000 clerical hours, there are 2,000 hours of supervision used (the hours used by the supervising clerks activity, which is not listed above).

Required:

1. Prepare a work distribution matrix for the five primary activities.
2. Calculate the cost of each activity.
3. ***What if*** the cost of the supervising activity is assigned to the other four activities? Why would this be done? If it is done, what is the final cost of these four primary activities?

Cornerstone Exercise 6-7 SIMPLIFYING THE ABC SYSTEM: TDABC

OBJECTIVE 4
CORNERSTONE 6-7
SERVICE

Perlman Bank provided the following data about its resources and activities for its chequing account process:

Resources		Activities	Time per Unit	Activity Driver
Supervision	$ 70,000	Processing accounts	0.20 hr	No. of accounts
Phone and supplies	90,000	Issuing statements	0.10 hr	No. of statements
Salaries	275,000	Processing transactions	0.05 hr	No. of transactions
Computer	25,000	Answering customer inquiries	0.15 hr	No. of inquiries
Total	$460,000			
Total cheque processing hours	25,000 (practical capacity)			

Required:

1. Calculate the capacity cost rate for the chequing account process.
2. Calculate the activity rates for the four activities. If the total number of statements issued was 20,000, calculate the cost of the issuing statements activity.
3. ***What if*** process improvements decreased the number of customer inquiries, leading to a 10 percent reduction in cheque processing hours and a $10,000 reduction in total resource costs? Update all the activity rates for these changes in operating conditions.

Cornerstone Exercise 6-8 SIMPLIFYING THE ABC SYSTEM: APPROXIMATELY RELEVANT ABC SYSTEMS

OBJECTIVE 4
CORNERSTONE 6-8

Patra Company produces wafers for integrated circuits. Data for the most recent year are provided:

Activity		Driver	Expected Consumption Ratios: Wafer A	Wafer B
Inserting and sorting process activities:				
1. Developing test programs	$ 50,000	Engineering hours	0.25	0.75
2. Making probe cards	60,000	Development hours	0.10	0.90
3. Testing products	600,000	Test hours	0.60	0.40
4. Setting up batches	135,000	Number of batches	0.55	0.45
5. Engineering design	90,000	Number of change orders	0.15	0.85
6. Handling wafer lots	300,000	Number of moves	0.45	0.55
7. Inserting dies	700,000	Number of dies	0.70	0.30
Procurement process activities:				
8. Purchasing materials	400,000	Number of purchase orders	0.20	0.80
9. Unloading materials	60,000	Number of receiving orders	0.35	0.65
10. Inspecting materials	75,000	Inspection hours	0.65	0.35
11. Moving materials	500,000	Distance moved	0.50	0.50
12. Paying suppliers	30,000	Number of invoices	0.30	0.70
Total activity cost	$3,000,000			

Unit-level (plantwide) cost assignment[a]	$2,100,000	$900,000
Activity cost assignment[b]	$1,500,000	$1,500,000

[a] Calculated using *number of dies* as the single unit-level driver
[b] Calculated by multiplying the consumption ratio of each product by the cost of each activity

Required:

1. Using the five most expensive activities, calculate the overhead cost assigned to each product. Assume that the costs of the other activities are assigned in proportion to the cost of the five activities.
2. Calculate the error relative to the fully specified ABC product cost and comment on the outcome.
3. ***What if*** activities 1, 2, 5, and 8 each had a cost of $650,000 and the remaining activities had a cost of $50,000? Calculate the cost assigned to Wafer A by a fully specified ABC system and then by an approximately relevant ABC approach. Comment on the implications for the approximately relevant approach.

OBJECTIVE 4

CORNERSTONE 6-9

Cornerstone Exercise 6-9 SIMPLIFYING THE ABC SYSTEM: EQUALLY ACCURATE REDUCED ABC SYSTEMS

Selected activities and other information are provided for Patra Company for its most recent year of operations.

Activity	Driver	Quantity	Expected Consumption Ratios: Wafer A	Wafer B
7. Inserting dies	Number of dies	2,000,000	0.70	0.30
8. Purchasing materials	Number of purchase orders	2,500	0.20	0.80
1. Developing test programs	Engineering hours	10,000	0.25	0.75
3. Testing products	Test hours	20,000	0.60	0.40
ABC assignment			$1,500,000	$1,500,000
Total overhead cost				$3,000,000

Required:

1. Form reduced system cost pools for activities 7 and 8.
2. Assign the costs of the reduced system cost pools to Wafer A and Wafer B.
3. ***What if*** the two activities were 1 and 3? Repeat Requirements 1 and 2. What does this imply?

Exercises

Exercise 6-10 PREDETERMINED OVERHEAD RATE, APPLIED OVERHEAD, UNIT COST

OBJECTIVE 1

Glencoe Inc. costs products using a normal costing system. The following data are available for last year:

Budgeted:	
Overhead	$476,000
Machine hours	140,000
Direct labour hours	17,000
Actual:	
Overhead	$475,000
Machine hours	137,000
Direct labour hours	16,550
Prime cost	$1,750,000
Number of units	250,000

Overhead is applied on the basis of direct labour hours.

Required:

1. What was the predetermined overhead rate?
2. What was the applied overhead for last year?
3. Was overhead over- or underapplied, and by how much?
4. What was the total cost per unit produced (carry your answer to four significant digits)?

Exercise 6-11 PREDETERMINED OVERHEAD RATE, APPLICATION OF OVERHEAD

OBJECTIVE 1

Jackson Company and Jalil Company both use predetermined overhead rates to apply manufacturing overhead to production. Jackson's is based on machine hours, and Jalil's is based on materials cost. Budgeted production and cost data for Jackson and Jalil are as follows:

	Jackson	Jalil
Manufacturing overhead	$608,000	$660,000
Units	20,000	60,000
Machine hours	32,000	22,500
Materials cost	$300,000	$1,200,000

At the end of the year, Jackson Company had incurred overhead of $610,000 and had produced 19,600 units using 31,980 machine hours and materials costing $294,000. Jalil Company had incurred overhead of $648,000 and had produced 61,500 units using 22,650 machine hours and materials costing $1,185,000.

Required:

1. Compute the predetermined overhead rates for Jackson Company and Jalil Company.
2. Was overhead over- or underapplied for each company, and by how much?

Exercise 6-12 PREDETERMINED OVERHEAD RATE, OVERHEAD VARIANCES, JOURNAL ENTRIES

OBJECTIVE 1

Menotti Company uses a predetermined overhead rate to assign overhead to jobs. Because Menotti's production is machine intensive, overhead is applied on the basis of machine hours. The expected overhead for the year was $3.8 million, and the practical level of activity is 250,000 machine hours.

During the year, Menotti used 255,000 machine hours and incurred actual overhead costs of $3.82 million. Menotti also had the following balances of applied overhead in its accounts:

Work-in-process inventory	$ 384,000
Finished goods inventory	416,000
Cost of goods sold	1,200,000

Required:

1. Compute a predetermined overhead rate for Menotti.
2. Compute the overhead variance, and label it as under- or overapplied.
3. Assuming the overhead variance is immaterial, prepare the journal entry to dispose of the variance at the end of the year.
4. Assuming the overhead variance is material, prepare the journal entry that appropriately disposes of the variance at the end of the year.

OBJECTIVE 1

Exercise 6-13 DEPARTMENTAL OVERHEAD RATES

Narpet Company produces machine tools and currently uses a plantwide overhead rate, based on machine hours. Ray Johnson, the plant manager, has heard that departmental overhead rates can offer significantly better cost assignments than can a plantwide rate. Narpet has the following data for its two departments for the coming year:

	Department A	Department B
Overhead costs (expected)	$240,000	$60,000
Normal activity (machine hours)	40,000	20,000

Required:

1. Compute a predetermined overhead rate for the plant as a whole based on machine hours.
2. Compute predetermined overhead rates for each department using machine hours.
3. Suppose that a machine tool (Product #12X75) used 20 machine hours from Department A and 50 machine hours from Department B. A second machine tool (Product #32Y15) used 50 machine hours from Department A and 20 machine hours from Department B. Compute the overhead cost assigned to each product using the plantwide rate computed in Requirement 1. Repeat the computation using the departmental rates found in Requirement 2. Which of the two approaches gives the fairest assignment? Why?
4. Repeat Requirement 3 assuming the expected overhead cost for Department B is $120,000. Now would you recommend departmental rates over a plantwide rate?

OBJECTIVE 2

CORNERSTONE 6-3

Exercise 6-14 DRIVERS AND PRODUCT COSTING ACCURACY

Balint Company produces two types of leather purses: standard and handcrafted. Both purses use equipment for cutting and stitching. The equipment also has the capability of creating standard designs. The standard purses use only these standard designs. They are all of the same size to accommodate the design features of the equipment. The handcrafted purses can be cut to any size because the designs are created manually. Many of the manually produced designs are in response to specific requests of retailers. The equipment must be specially configured to accommodate the production of a batch of purses that will receive a handcrafted design. Balint Company assigns overhead using direct labour dollars. Merle Jones, sales manager, is convinced that the purses are not being costed correctly.

To illustrate his point, he decided to focus on the expected annual setup and machine-related costs, which are as follows:

Setup equipment	$18,000
Depreciation	20,000*
Operating costs	22,000

*Computed on a straight-line basis, book value at the beginning of the year was $100,000.

The machine has the capability of supplying 100,000 machine hours over its remaining life.

Merle also collected the expected annual prime costs for each purse, the machine hours, and the expected production (which is the normal output for the company).

	Standard Purse	Handcrafted Purse
Direct labour	$12,000	$36,000
Direct materials	$12,000	$12,000
Units	3,000	3,000
Machine hours	18,000	2,000
Number of setups	40	40
Setup time	400 hrs	200 hrs

Required:

1. Do you think that the direct labour costs and direct materials costs are accurately traced to each type of purse? Explain.
2. The controller has suggested that overhead costs be assigned to each product using a plantwide rate based on direct labour dollars. Machine costs and setup costs are overhead costs. Assume that these are the only overhead costs. For each type of purse, calculate the overhead per unit that would be assigned using a direct labour dollars overhead rate. Do you think that these costs are traced accurately to each purse? Explain.
3. Now calculate the overhead cost per unit per purse using two overhead rates: one for the setup activity and one for the machining activity. In choosing a driver to assign the setup costs, did you use number of setups or setup hours? Why? As part of your explanation, define transaction and duration drivers. Do you think machine costs are traced accurately to each type of purse? Explain.

Exercise 6-15 MULTIPLE VERSUS SINGLE OVERHEAD RATES, ACTIVITY DRIVERS

OBJECTIVE 3 4

Tardif Company has identified the following overhead activities, costs, and activity drivers for the coming year:

Activity	Expected Cost	Activity Driver	Activity Capacity
Setting up equipment	$120,000	Number of setups	300
Ordering costs	90,000	Number of orders	9,000
Machine costs	210,000	Machine hours	21,000
Receiving	100,000	Receiving hours	5,000

Tardif produces two models of dishwashers with the following expected prime costs and activity demands:

	Model A	Model B
Direct materials	$150,000	$200,000
Direct labour	$120,000	$120,000
Units completed	8,000	4,000
Direct labour hours	3,000	1,000
Number of setups	200	100
Number of orders	3,000	6,000
Machine hours	12,000	9,000
Receiving hours	1,500	3,500

The company's normal activity is 4,000 direct labour hours.

Required:

1. Determine the unit cost for each model using direct labour hours to apply overhead.
2. Determine the unit cost for each model using the four activity drivers.
3. Which method produces the more accurate cost assignment? Why?

Exercise 6-16 ACTIVITY-BASED COSTING, ACTIVITY IDENTIFICATION, ACTIVITY DICTIONARY

OBJECTIVE 3

SERVICE

Perlman Bank is in the process of implementing an activity-based costing system. A copy of an interview with the manager of Perlman's Credit Card Department follows.

QUESTION 1: How many employees are in your department?

RESPONSE: There are eight employees, including me.

QUESTION 2: What do they do (please describe)?

RESPONSE: There are four major activities: supervising employees, processing credit card transactions, issuing customer statements, and answering customer questions.

QUESTION 3: Do customers outside your department use any equipment?

RESPONSE: Yes. Automatic bank tellers service customers who require cash advances.

QUESTION 4: What resources are used by each activity (equipment, materials, energy)?

RESPONSE: We each have our own computer, printer, and desk. Paper and other supplies are needed to operate the printers. Of course, we each have a telephone as well.

QUESTION 5: What are the outputs of each activity?

RESPONSE: Well, for supervising, I manage employees' needs and try to ensure that they carry out their activities efficiently. Processing transactions produces a posting for each transaction in our computer system and serves as a source for preparing the monthly statements. The number of monthly customer statements has to be the product for the issuing activity, and I suppose that the number of customers served is the output for the answering activity. And I guess that the number of cash advances would measure the product of the automatic teller activity, although the teller really generates more transactions for other products such as chequing and savings accounts. So, perhaps the number of teller transactions is the real output.

QUESTION 6: Who or what uses the activity output?

RESPONSE: We have three products: classic, gold, and platinum credit cards. Transactions are processed for these three types of cards, and statements are sent to clients holding these cards. Similarly, answers to questions are all directed to clients who hold these cards. As far as supervising, I spend time ensuring the proper coordination and execution of all activities except for the automatic teller. I really have no role in managing that particular activity.

QUESTION 7: How much time do workers spend on each activity? By equipment?

RESPONSE: I just completed a work survey and have the percentage of time calculated for each worker. All seven clerks work on each of the three departmental activities. About 40 percent of their time is spent processing transactions, with the rest of their time split evenly between issuing statements and answering questions. Phone time for all seven workers is used only for answering client questions. Computer time is 70 percent transaction processing, 20 percent statement preparation, and 10 percent question answering. Furthermore, my own time and that of my computer and telephone are 100 percent administrative. Credit card transactions represent about 20 percent of the total automatic teller transactions.

Required:

Prepare an activity dictionary using five columns: activity name, activity description, activity type (primary or secondary), cost object(s), and activity driver.

OBJECTIVE 3

SERVICE

Exercise 6-17 ASSIGNING RESOURCE COSTS TO ACTIVITIES, RESOURCE DRIVERS, PRIMARY AND SECONDARY ACTIVITIES

Refer to the interview in **Exercise 6-16** (especially to Questions 4 and 7). The general ledger reveals the following annual costs:

Supervisor's salary	$ 64,600
Clerical salaries	210,000
Computers, desks, and printers	32,000
Computer supplies	7,200
Telephone expenses	4,000
ATM	1,250,000

All nonlabour resources, other than the ATM, are spread evenly among the eight credit department employees (in terms of assignment and usage). Credit department employees have no contact with ATMs. Printers and desks are used in the same ratio as computers by the various activities.

Required:

1. Determine the cost of all primary and secondary activities.
2. Assign the cost of secondary activities to the primary activities.

OBJECTIVE 3

Exercise 6-18 ASSIGNING RESOURCE COSTS TO ACTIVITIES, RESOURCE DRIVERS, PRIMARY AND SECONDARY ACTIVITIES

Bob Randall, cost accounting manager for Hemple Products, was asked to determine the costs of the activities performed within the company's Manufacturing Engineering Department. The department has the following activities: creating bills of materials (BOMs), studying manufacturing capabilities, improving manufacturing processes, training employees, and designing tools. The general ledger accounts reveal the following expenditures for Manufacturing Engineering:

Salaries	$500,000
Equipment	100,000
Supplies	30,000
Total	$630,000

The equipment is used for two activities: improving processes and designing tools. The equipment's time is divided by two activities: 40 percent for improving processes and 60 percent for designing tools. The salaries are for nine engineers, one who earns $100,000 and eight who earn $50,000 each. The $100,000 engineer spends 40 percent of her time training employees in new processes and 60 percent of her time on improving processes. One engineer spends 100 percent of her time on designing tools, and another engineer spends 100 percent of his time on improving processes. The remaining six engineers spend equal time on all activities. Supplies are consumed in the following proportions:

Creating BOMs	10%
Studying capabilities	5
Improving processes	35
Training employees	20
Designing tools	30

After determining the costs of the engineering activities, Bob was then asked to describe how these costs would be assigned to jobs produced within the factory. (The company manufactures machine parts on a job-order basis.) Bob responded by indicating that creating BOMs and designing tools were the only primary activities. The remaining were secondary activities. After some analysis, Bob concluded that studying manufacturing capabilities was an activity that enabled the other four activities to be realized. He also noted that all of the employees being trained are manufacturing workers—employees who work directly on the products. The major manufacturing activities are cutting, drilling, lathing, welding, and assembly. The costs of these activities are assigned to the various products using hours of usage (grinding hours, drilling hours, etc.). Furthermore, tools were designed to enable the production of specific jobs. Finally, the process improvement activity focused only on the five major manufacturing activities.

Required:

1. What is meant by unbundling general ledger costs? Why is it necessary?
2. What is the difference between a general ledger database system and an activity-based database system?
3. Using the resource drivers and direct tracing, calculate the costs of each manufacturing engineering activity. What are the resource drivers?
4. Describe in detail how the costs of the engineering activities would be assigned to jobs using activity-based costing. Include a description of the activity drivers that might be used. Where appropriate, identify both a possible transaction driver and a possible duration driver.

OBJECTIVE 3

Exercise 6-19 PROCESS IDENTIFICATION AND ACTIVITY CLASSIFICATION

Calzado Company produces leather shoes in batches. The shoes are produced in one plant located on 20 acres. The plant operates two shifts, five days per week. Each time a batch is produced, just-in-time suppliers deliver materials to the plant. When the materials arrive, a worker checks the quantity and type of materials with the bill of materials for the batch. The worker then makes an entry at a PC terminal near the point of delivery acknowledging receipt of the material. An accounts payable clerk reviews all deliveries at the end of each day and then prints and mails cheques the same day materials are received. Prior to producing a batch, the equipment must be configured to reflect style and size features. Once configured, the batch is produced passing through three operations: cutting, sewing, and attaching buckles and other related parts such as heels. At the end of the production process, a sample of shoes is inspected to ensure the right level of quality.

After inspection, the batch is divided into lots based on the customer orders for the shoes. The lots are packaged in boxes and then transferred to a staging area to await shipment. After a short wait (usually within two hours), the lots are loaded onto trucks and delivered to customers (retailers).

Within the same plant, the company also has a team of design engineers who respond to customer feedback on style and comfort issues. This department modifies existing designs, develops new shoe designs, builds prototypes, and test markets the prototypes before releasing the designs for full-scale production.

Required:

1. Identify Calzado's processes and their associated activities.
2. Classify each activity within each process as unit-level, batch-level, product-level, or facility-level.

OBJECTIVE 4

Exercise 6-20 TDABC

Bob Randall, cost accounting manager for Hemple Products, was asked to determine the costs of the activities performed within the company's Manufacturing Engineering Department. The department has the following activities: creating bills of materials (BOMs), studying manufacturing capabilities, improving manufacturing processes, training employees, and designing tools. The resource costs (from the general ledger) and the times to perform one unit of each activity are provided below.

Resource Costs		Activities	Unit Time	Driver
Salaries	$500,000	Creating BOMs	0.5 hr	No. of BOMs
Equipment	100,000	Designing tools	5.4 hrs	No. of tool designs
Supplies	30,000	Improving processes	1.0 hr	Process improvement hrs
Total	$630,000	Training employees	2.0 hrs	No. of training sessions

Total machine and labour hours (at practical capacity):

Machine hours	2,000
Engineering hours	18,000
Total hours	20,000

The activity, designing tools, uses number of tools designed as the activity driver. Using a traditional approach, the cost of the designing tools activity was determined to be $179,000 (see Exercise 6-18) with an expected activity output of 1,000 for the coming year. During the first week of the year, two jobs (Job 150 and Job 151) had a demand for 10 and 20 new tools, respectively.

Required:

1. Calculate the capacity cost rate for the Manufacturing Engineering Department.
2. Using the capacity cost rate, determine the activity rates for each activity.
3. Calculate the cost of designing tools that would be assigned to each job using the TDABC derived activity rate and then repeat using the traditional ABC rate. What might be the cause or causes that would explain the differences in the two approaches?
4. Now suppose that time for creating BOMs is 0.5 for a standard product but that creating a BOM for a custom product adds an additional 0.3 hour. Express the time equation for this added complexity and then calculate the activity rate for the activity of creating a BOM for custom products.

Exercise 6-21 APPROXIMATELY RELEVANT ABC

OBJECTIVE 4

Silva Company has identified the following overhead activities, costs, and activity drivers for the coming year:

Activity	Expected Cost	Activity Driver	Activity Capacity
Setting up equipment	$126,000	Number of setups	150
Ordering materials	18,000	Number of orders	900
Machining	126,000	Machine hours	10,500
Receiving	30,000	Receiving hours	1,250

Silva produces two models of cell phones with the following expected activity demands:

	Model X	Model Y
Units completed	5,000	10,000
Number of setups	100	50
Number of orders	300	600
Machine hours	6,000	4,500
Receiving hours	375	875

Required:

1. Determine the total overhead assigned to each product using the four activity drivers.
2. Determine the total overhead assigned to each model using the two most expensive activities. The costs of the two relatively inexpensive activities are allocated to the two expensive activities in proportion to their costs.
3. Using ABC as the benchmark, calculate the percentage error and comment on the accuracy of the reduced system. Explain why this approach may be desirable.

Exercise 6-22 EQUALLY ACCURATE REDUCED ABC SYSTEM

OBJECTIVE 4

Refer to **Exercise 6-21**.

Required:

1. Calculate the global consumption ratios for the two products.
2. Using the activity consumption ratios for number of orders and number of setups, show that the same cost assignment can be achieved using these two drivers as that of the complete, four-driver ABC system.

Problems

OBJECTIVE 1

Problem 6-23 PREDETERMINED OVERHEAD RATES, OVERHEAD VARIANCES, UNIT COSTS

Ultima Company produces two products and uses a predetermined overhead rate to apply overhead. Ultima currently applies overhead using a plantwide rate based on direct labour hours. Consideration is being given to the use of departmental overhead rates where overhead would be applied on the basis of direct labour hours in Department 1 and on the basis of machine hours in Department 2. At the beginning of the year, the following estimates are provided:

	Department 1	Department 2
Direct labour hours	800,000	160,000
Machine hours	20,000	240,000
Overhead cost	$480,000	$1,440,000

Actual results reported by department and product during the year are as follows:

	Department 1	Department 2
Direct labour hours	784,000	168,000
Machine hours	22,000	256,000
Overhead cost	$500,000	$1,540,000

	Product 1	Product 2
Direct labour hours:		
Department 1	600,000	184,000
Department 2	120,000	48,000
Machine hours:		
Department 1	10,000	12,000
Department 2	56,000	200,000

Required:

1. Compute the plantwide predetermined overhead rate and calculate the overhead assigned to each product.
2. Calculate the predetermined departmental overhead rates and calculate the overhead assigned to each product.
3. Using departmental rates, compute the applied overhead for the year. What is the under- or overapplied overhead for the firm?
4. Prepare the journal entry that disposes of the overhead variance calculated in Requirement 3, assuming it is not material in amount. What additional information would you need if the variance is material to make the appropriate journal entry?

OBJECTIVE 2

Problem 6-24 UNIT-BASED VERSUS ACTIVITY-BASED COSTING

Apollo Company produces exercise bikes. One of its plants produces two versions: a standard model and a deluxe model. The deluxe model has a wider and sturdier base and a variety of electronic gadgets to help the exerciser monitor heartbeat, calories burned, distance travelled, and so on. At the beginning of the year, the following data were prepared for this plant:

	Standard Model	Deluxe Model
Expected quantity	30,000	15,000
Selling price	$370	$700
Prime costs	$4.5 million	$5.25 million
Machine hours	37,500	37,500
Direct labour hours	75,000	75,000
Engineering support (hours)	13,500	31,500
Receiving (orders processed)	3,000	4,500

	Standard Model	Deluxe Model
Materials handling (number of moves)	15,000	45,000
Purchasing (number of requisitions)	750	1,500
Maintenance (hours used)	6,000	24,000
Paying suppliers (invoices processed)	3,750	3,750
Setting up batches (number of setups)	60	540

Additionally, the following overhead activity costs are reported:

Maintenance	$ 600,000
Engineering support	900,000
Materials handling	1,200,000
Setups	750,000
Purchasing	450,000
Receiving	300,000
Paying suppliers	300,000
	$4,500,000

Required:

1. Calculate the cost per unit for each product using direct labour hours to assign all overhead costs.
2. Calculate activity rates and determine the overhead cost per unit. Compare these costs with those calculated using the unit-based method. Which cost is the most accurate? Explain.

Problem 6-25 ABC, RESOURCE DRIVERS, SERVICE INDUSTRY

OBJECTIVE 2 3

SERVICE

Cushing Medical Clinic operates a cardiology care unit and a maternity care unit. Ned Carson, the clinic's administrator, is investigating the charges assigned to cardiology patients. Currently, all cardiology patients are charged the same rate per patient day for daily care services. Daily care services are broadly defined as occupancy, feeding, and nursing care. A recent study, however, has revealed several interesting outcomes. First, the demands patients place on daily care services vary with the severity of the case being treated. Second, the occupancy activity is a combination of two activities: lodging and use of monitoring equipment. Since some patients require more monitoring than others, these activities should be separated. Third, the daily rate should reflect the differences in demands resulting from differences in patient type. Separating the occupancy activity into two separate activities would also require the determination of the cost of each activity. Determining the costs of the monitoring activity will be fairly easy because its costs are directly traceable. Lodging costs, however, are shared by two activities: lodging cardiology patients and lodging maternity care patients. The total lodging costs for the two activities are $3,800,000 per year and consist of such items as building depreciation, building maintenance, and building utilities. The cardiology floor and the maternity floor each occupy 20,000 square metres. Carson has determined that lodging costs will be assigned to each unit based on square metres.

To compute a daily rate that reflects the difference in demands, patients are placed in three categories according to illness severity, and the following annual data have been collected:

Activity	Cost of Activity	Activity Driver	Quantity
Lodging	$1,900,000	Patient days	15,000
Monitoring	1,400,000	Monitoring hours used	20,000
Feeding	300,000	Patient days	15,000
Nursing care	3,000,000	Nursing hours	150,000
Total	$6,600,000		

The demands associated with patient severity are also provided:

Severity	Patient Days	Monitoring Hours	Nursing Hours
High	5,000	10,000	90,000
Medium	7,500	8,000	50,000
Low	2,500	2,000	10,000

Required:

1. Suppose that the costs of daily care are assigned using only patient days as the activity driver (which is also the measure of output). Compute the daily rate using this unit-based approach of cost assignment.
2. Compute activity rates using the given activity drivers (combine activities with the same driver).
3. Compute the charge per patient day for each patient type using the activity rates from Requirement 2 and the demands on each activity.
4. Suppose that the product is defined as "stay and treatment" where the treatment is bypass surgery. What additional information would you need to cost out this newly defined product?
5. Comment on the value of activity-based costing in service industries.

OBJECTIVE 2 3

SERVICE

Problem 6-26 ACTIVITY-BASED COSTING, SERVICE FIRM

The First National Bank operated for years under the assumption that profitability can be increased by increasing dollar volumes. Historically, First National's efforts were directed toward increasing total dollars of sales and total dollars of account balances. In recent years, however, First National's profits have been eroding. Increased competition, particularly from credit unions, was the cause of the difficulties. As key managers discussed the bank's problems, it became apparent that they had no idea what their products were costing. Upon reflection, they realized that they had often made decisions to offer a new product that promised to increase dollar balances without any consideration of what it cost to provide the service.

After some discussion, the bank decided to hire a consultant to compute the costs of three products: chequing accounts, personal loans, and the gold VISA. The consultant identified the following activities, costs, and activity drivers (annual data):

Activity	Activity Cost	Activity Driver	Activity Capacity
Providing ATM service	$ 100,000	No. of transactions	200,000
Computer processing	1,000,000	No. of transactions	2,500,000
Issuing statements	800,000	No. of statements	500,000
Customer inquiries	360,000	Telephone minutes	600,000

The following annual information on the three products was also made available:

	Chequing Accounts	Personal Loans	Gold VISA
Units of product	30,000	5,000	10,000
ATM transactions	180,000	0	20,000
Computer transactions	2,000,000	200,000	300,000
Number of statements	300,000	50,000	150,000
Telephone minutes	350,000	90,000	160,000

In light of the new cost information, Larry Roberts, the bank president, wanted to know whether a decision made two years ago to modify the bank's chequing account product was sound. At that time, the service charge was eliminated on accounts with an average annual balance greater than $1,000. Based on increases in the total dollars in chequing, Larry was pleased with the new product. The chequing account product is described as follows: (1) chequing account balances greater than $500 earn interest of 2 percent per year, and (2) a service charge of $5 per month is charged for balances less than $1,000. The bank earns 4 percent on chequing account deposits. Fifty percent of the accounts are less than $500 and have an

average balance of $400 per account. Ten percent of the accounts are between $500 and $1,000 and average $750 per account. Twenty-five percent of the accounts are between $1,000 and $2,767; the average balance is $2,000. The remaining accounts carry a balance greater than $2,767. The average balance for these accounts is $5,000. Research indicates that the $2,000 category was by far the greatest contributor to the increase in dollar volume when the chequing account product was modified two years ago.

Required:

1. Calculate rates for each activity.
2. Using the rates computed in Requirement 1, calculate the cost of each product.
3. Evaluate the chequing account product. Are all accounts profitable? Compute the average annual profitability per account for the four categories of accounts described in the problem. What recommendations would you make to increase the profitability of the chequing account product? (Break-even analysis for the unprofitable categories may be helpful).

Problem 6-27 PRODUCT COSTING ACCURACY, CORPORATE STRATEGY, ABC

OBJECTIVE ➤ 2 3

Autotech Manufacturing is engaged in the production of replacement parts for automobiles. One plant specializes in the production of two parts: Part #127 and Part #234. Part #127 produced the highest volume of activity, and for many years it was the only part produced by the plant. Five years ago, Part #234 was added. Part #234 was more difficult to manufacture and required special tooling and setups. Profits increased for the first three years after the addition of the new product. In the last two years, however, the plant has faced intense competition, and its sales of Part #127 have dropped. In fact, the plant showed a small loss in the most recent reporting period. Much of the competition was from foreign sources, and the plant manager was convinced that the foreign producers were guilty of selling the part below the cost of producing it. The following conversation between Patty Burt, plant manager, and Joseph Fielding, divisional marketing manager, reflects the concerns of the division about the future of the plant and its products.

JOSEPH: You know, Patty, the divisional manager is real concerned about the plant's trend. He indicated that in this budgetary environment, we can't afford to carry plants that don't show a profit. We shut one down just last month because it couldn't handle the competition.

PATTY: Joe, you and I both know that Part #127 has a reputation for quality and value. It has been a mainstay for years. I don't understand what's happening.

JOSEPH: I just received a call from one of our major customers concerning Part #127. He said that a sales representative from another firm offered the part at $20 per unit—$11 less than what we charge. It's hard to compete with a price like that. Perhaps the plant is simply obsolete.

PATTY: No. I don't buy that. From my sources, I know we have good technology. We are efficient. And it's costing a little more than $21 to produce that part. I don't see how these companies can afford to sell it so cheaply. I'm not convinced that we should meet the price. Perhaps a better strategy is to emphasize producing and selling more of Part #234. Our margin is high on this product, and we have virtually no competition for it.

JOSEPH: You may be right. I think we can increase the price significantly and not lose business. I called a few customers to see how they would react to a 25 percent increase in price, and they all said that they would still purchase the same quantity as before.

PATTY: It sounds promising. However, before we make a major commitment to Part #234, I think we had better explore other possible explanations. I want to know how our production costs compare to those of our competitors. Perhaps we could be more efficient and find a way to earn our normal return on Part #127. The market is so much

bigger for this part. I'm not sure we can survive with only Part #234. Besides, my production people hate that part. It's very difficult to produce.

After her meeting with Joseph, Patty requested an investigation of the production costs and comparative efficiency. She received approval to hire a consulting group to make an independent investigation. After a three-month assessment, the consulting group provided the following information on the plant's production activities and costs associated with the two products:

	Part #127	Part #234
Production	500,000	100,000
Selling price	$31.86	$24.00
Overhead per unit*	$12.83	$5.77
Prime cost per unit	$8.53	$6.26
Number of production runs	100	200
Receiving orders	400	1,000
Machine hours	125,000	60,000
Direct labour hours	250,000	22,500
Engineering hours	5,000	5,000
Material moves	500	400

*Calculated using a plantwide rate based on direct labour hours. This is the current way of assigning the plant's overhead to its products.

The consulting group recommended switching the overhead assignment to an activity-based approach. It maintained that activity-based cost assignment is more accurate and will provide better information for decision making. To facilitate this recommendation, it grouped the plant's activities into homogeneous sets with the following costs:

Overhead:	
Setup costs	$ 240,000
Machine costs	1,750,000
Receiving costs	2,100,000
Engineering costs	2,000,000
Materials handling costs	900,000
Total	$6,990,000

Required:

1. Verify the overhead cost per unit reported by the consulting group using direct labour hours to assign overhead. Compute the per-unit gross margin for each product.
2. After learning of activity-based costing, Patty asked the controller to compute the product cost using this approach. Recompute the unit cost of each product using activity-based costing. Compute the per-unit gross margin for each product.
3. Should the company switch its emphasis from the high-volume product to the low-volume product? Comment on the validity of the plant manager's concern that competitors are selling below the cost of making Part #127.
4. Explain the apparent lack of competition for Part #234. Comment also on the willingness of customers to accept a 25 percent increase in price for Part #234.
5. Assume that you are the manager of the plant. Describe what actions you would take based on the information provided by the activity-based unit costs.

OBJECTIVE 4

SERVICE

Problem 6-28 TIME-DRIVEN ACTIVITY-BASED COSTING COMPARED TO ABC, STAGE 1

The Bienestar Cardiology Clinic has two major activities: diagnostic and treatment. The two activities use four resources: nursing, medical technicians, cardiologists, and equipment. Detailed interviews have provided the following work distribution matrix:

	Resources				
Activity	Nursing	Technicians	Cardiologists	Equipment	Total Activity Time
Diagnosing patients	0.70	0.80	0.40	0.60	12,000 hrs
Treating patients	0.30	0.20	0.60	0.40	8,000 hrs
Total time (hrs)	4,000	4,000	6,000	6,000	20,000
Cost	$80,000	$80,000	$320,000	$320,000	

The total time estimated corresponds to practical capacity (interviewers adjusted the total time to about 80 percent of the available time). The equipment time is measured in machine hours. Thus, the total time (at practical capacity) in the system is 20,000 hours. In considering the implementation of a TDABC model, the following unit times and transaction information are also provided:

	Unit Time	Driver	Expected Activity Driver Quantity
Diagnosing patients	3 hrs	No. of patients	4,000
Treating patients	0.8 hr	No. of treatments	10,000

Required:

1. Calculate the cost of each activity using the indicated values of the resource drivers.
2. Calculate the capacity cost rate for TDABC. Using the capacity cost rate, calculate the cost of each activity under TDABC. Compare these values with those obtained in Requirement 1 and discuss possible reasons for any differences.
3. Suppose that the actual activity driver quantities are 3,500 and 9,000. Calculate the cost of unused capacity.
4. Suppose that the clinic acquires new equipment that reduces the total time required for the two activities from 20,000 to 18,000 hours. The equipment cost remains the same. Explain how the ABC system would be updated and then describe how TDABC would provide updates.
5. Suppose that diagnosing patients without any cardiac disease takes two hours while diagnosing patients with mildly diseased hearts takes an additional 1.5 hours and those with more severe problems takes four hours. Prepare a time equation and using the capacity cost rate from Requirement 2, calculate the activity rate for each of the three types of patients.

Problem 6-29 ACTIVITY-BASED COSTING, REDUCING THE NUMBER OF DRIVERS WITH EQUAL ACCURACY

OBJECTIVE 2 4

Reducir Inc. produces two different types of hydraulic cylinders. Reducir produces a major subassembly for the cylinders in the Cutting and Welding Department. Other parts and the subassembly are then assembled in the Assembly Department. The activities, expected costs, and drivers associated with these two manufacturing processes are given below.

Process	Activity	Cost	Activity Driver	Expected Quantity
Cutting and Welding	Welding	$ 776,000	Welding hours	4,000
	Machining	450,000	Machine hours	10,000
	Inspecting	448,250	No. of inspections	1,000
	Materials handling	300,000	No. of moves	12,000
	Setups	240,000	No. of setups	100
		$2,214,250		
Assembly	Changeover	$ 180,000	Changeover hours	1,000
	Rework	61,750	Rework orders	50
	Testing	300,000	No. of tests	750
	Materials handling	380,000	No. of parts	50,000
	Engineering support	130,000	Engineering hours	2,000
		$1,051,750		

Note: In the assembly process, the materials handling activity is a function of product characteristics rather than batch activity.

Other overhead activities, their costs, and drivers are listed below.

Activity	Cost	Activity Driver	Quantity
Purchasing	$135,000	Purchase requisitions	500
Receiving	274,000	Receiving orders	2,000
Paying suppliers	225,000	No. of invoices	1,000
Providing space and utilities	100,000	Machine hours	10,000
	$734,000		

Other production information concerning the two hydraulic cylinders is also provided:

	Cylinder A	Cylinder B
Units produced	1,500	3,000
Welding hours	1,600	2,400
Machine hours	3,000	7,000
Inspections	500	500
Moves	7,200	4,800
Setups	45	55
Changeover hours	540	460
Rework orders	5	45
No. of tests	500	250
Parts	40,000	10,000
Engineering hours	1,500	500
Requisitions	425	75
Receiving orders	1,800	200
Invoices	650	350

Required:

1. Using a plantwide rate based on machine hours, calculate the total overhead cost assigned to each product and the unit overhead cost.
2. Using activity rates, calculate the total overhead cost assigned to each product and the unit overhead cost. Comment on the accuracy of the plantwide rate.
3. Calculate the global consumption ratios.
4. Calculate the consumption ratios for welding and materials handling (Assembly) and show that two drivers, welding hours and number of parts, can be used to achieve the same ABC product costs calculated in Requirement 2. Explain the value of this simplification.
5. Calculate the consumption ratios for inspection and engineering and show that the drivers for these two activities also duplicate the ABC product costs calculated in Requirement 2.

OBJECTIVE 2

Problem 6-30 APPROXIMATELY RELEVANT ABC

Refer to the data given in **Problem 6-29** and suppose that the expected activity costs are reported as follows (all other data remain the same):

Process	Activity	Cost
Cutting and Welding	Welding	$2,000,000
	Machining	1,000,000
	Inspecting	50,000
	Materials handling	72,000
	Setups	400,000
		$3,522,000
Assembly	Changeover	$ 28,000
	Rework	50,000
	Testing	40,000
	Materials handling	60,000
	Engineering support	70,000
		$ 248,000

Other overhead activities:

Activity	Cost
Purchasing	$ 50,000
Receiving	70,000
Paying suppliers	80,000
Providing space and utilities	30,000
	$230,000

The per unit overhead cost using the 14 activity-based drivers is $1,108 and $779 for Cylinder A and Cylinder B, respectively.

Required:

1. Determine the percentage of total costs represented by the three most expensive activities.
2. Allocate the costs of all other activities to the three activities identified in Requirement 1. Allocate the other activity costs to the three activities in proportion to their individual activity costs. Now assign these total costs to the products using the drivers of the three chosen activities.
3. Using the costs assigned in Requirement 2, calculate the percentage error using the ABC costs as a benchmark. Comment on the value and advantages of this ABC simplification.

Problem 6-31 PRODUCT COSTING ACCURACY, PLANTWIDE AND DEPARTMENTAL RATES, ABC

OBJECTIVE 1 2 4

Waterloo Company produces two type of calculators: scientific and business. Both products pass through two producing departments. The business calculator is by far the most popular. The following data have been gathered for these two products:

	Product-Related Data	
	Scientific	Business
Units produced per year	75,000	750,000
Prime costs	$250,000	$2,500,000
Direct labour hours	100,000	1,000,000
Machine hours	50,000	500,000
Production runs	100	150
Inspection hours	2,000	3,000
Maintenance hours	2,250	9,000

	Department Data	
	Department 1	Department 2
Direct labour hours:		
Scientific calculator	75,000	25,000
Business calculator	112,500	887,500
Total	187,500	912,500
Machine hours:		
Scientific calculator	25,000	25,000
Business calculator	400,000	100,000
Total	425,000	125,000
Overhead costs:		
Setup costs	$225,000	$225,000
Inspection costs	175,000	175,000
Power	250,000	150,000
Maintenance	200,000	250,000
Total	$850,000	$800,000

Required:

1. Compute the overhead cost per unit for each product using a plantwide, unit-based rate using direct labour hours.
2. Compute the overhead cost per unit for each product using departmental rates. In calculating departmental rates, use machine hours for Department 1 and direct labour hours for Department 2. Repeat using direct labour hours for Department 1 and machine hours for Department 2.
3. Compute the overhead cost per unit for each product using activity-based costing.
4. Comment on the ability of departmental rates to improve the accuracy of product costing.

CMA Problem

CMA Problem 6-1 ACTIVITY-BASED COSTING*

Oineon Corporation manufactures several types of printed circuit boards; however, two of the boards account for most of the company's sales. The first board, a television circuit board, has been a standard in the industry for several years. The market for this type of board is competitive and, therefore, price sensitive. Oineon plans to sell 65,000 of the TV boards in 2013 at a price of $150 per unit. The second high-volume product, a personal computer (PC) circuit board, is a recent addition to Oineon's product line. Because the PC board incorporates the latest technology, it can be sold at a premium price. The 2013 plans include the sale of 40,000 PC boards at $300 per unit.

Oineon's management group is meeting to discuss strategies for 2013. The current topic of conversation is how to spend the sales and promotion dollars for next year. The sales manager believes that the market share for the TV board could be expanded by concentrating Oineon's promotional efforts in this area. In response to this suggestion, the production manager said, "Why don't you go after a bigger market for the PC board? The cost sheets I get show the contribution from the PC board is more than double the contribution from the TV board. I know we get a premium price for the PC board, so selling it should help overall profitability."

Oineon uses a standard cost system. The following data apply to the TV and PC boards:

	TV Board	PC Board
Direct material	$80	$140
Direct labour	1.5 hours	4 hours
Machine time	.5 hours	1.5 hours

Variable factory overhead is applied on the basis of direct labour hours. For 2013, variable factory overhead is budgeted at $1,120,000 and direct labour hours are estimated at $280,000. The hourly rates for machine time and direct labour are $10 and $14, respectively. Oineon applies a materials handling charge at 10 percent of material cost. This materials handling charge is not included in variable factory overhead. Total 2013 expenditures for material are budgeted at $10,600,000.

Ed Welch, Oineon's controller, believes that before management proceeds with the discussion about allocating sales and promotional dollars to individual products, it might be worthwhile to look at the products on the basis of the activities involved in their production. As Welch explained to the group, "Activity-based costing integrates the cost of all activities, known as cost drivers, into individual product costs rather than including these costs in overhead pools." Welch has prepared the schedule shown below to help management understand this concept.

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	Budgeted Cost	Cost Driver	Annual Activity for Cost Driver
Material overhead:			
Procurement	$ 400,000	Number of parts	4,000,000 parts
Production scheduling	220,000	Number of boards	110,000 boards
Packaging and shipping	440,000	Number of boards	110,000 boards
	$1,060,000		
Variable overhead:			
Machine setup	$ 446,000	Number of setups	278,750 setups
Hazardous waste disposal	48,000	Kilograms of waste	16,000 kilograms
Quality control	560,000	Number of inspections	160,000 inspections
General supplies	66,000	Number of boards	110,000 boards
	$1,120,000		
Manufacturing:			
Machine insertion	$1,200,000	Number of parts	3,000,000 parts
Manual insertion	4,000,000	Number of parts	1,000,000 parts
Wave soldering	132,000	Number of boards	110,000 boards
	$5,332,000		

Required Per Unit	TV Board	PC Board
Parts	25	55
Machine insertions	24	35
Manual insertions	1	20
Machine setups	2	3
Hazardous waste	.02 kg	.35 kg
Inspections	1	2

"Using this information," Welch explained, "we can calculate an activity-based cost for each TV and PC board and then compare it to the standard cost we have been using. The only cost that remains the same for both cost methods is the cost of direct material. The cost drivers will replace the direct labour, machine time, and overhead costs in the standard cost."

Required:

1. Prepare a gross profit report based on standard costs for each of the products.
2. Prepare a gross profit report based on activity-based costing for each of the products.
3. Comment on the likely actions that management would take if they used the report in Requirement 1 and if they used the report in Requirement 2.
   (Adapted from CMA Ontario)

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

1. Describe the difference between support departments and producing departments.
2. Calculate charging rates, and distinguish between single and dual charging rates.
3. Allocate support centre costs to producing departments using the direct method, the sequential method, and the reciprocal method.
4. Calculate departmental overhead rates.
5. Identify the characteristics of the joint production process, and allocate joint costs to products.

CHAPTER

7 Allocating Costs of Support Departments and Joint Products

Mutually beneficial costs, which occur when the same resource is used in the output of two or more services or products, are known as **common costs**. These common costs may pertain to periods of time, individual responsibilities, sales territories, and classes of customers. A special case of common costs is that of the joint production process. This chapter will first focus on the costs common to departments and to products, and then on the common costs of the joint production process.

OBJECTIVE 1

Describe the difference between support departments and producing departments.

An Overview of Cost Allocation

The complexity of many modern firms leads the accountant to allocate costs of support departments to producing departments and individual product lines. Allocation is simply a means of dividing a pool of costs and assigning those costs to various subunits. It is important to realize that allocation does not affect the total cost. Total cost is neither reduced nor increased by allocation. However, the amounts of cost assigned to the subunits can be affected by the allocation procedure chosen. Because

cost allocation can affect bid prices, the perceived profitability of individual products, and the behaviour of managers, it is an important topic.

Producing and Support Departments

There are two categories of departments: producing departments and support departments. **Producing departments** are directly responsible for creating the products or services sold to customers. In a large public accounting firm, examples of producing departments are auditing, tax, and management advisory services (computer systems services). In a manufacturing setting such as **Volkswagen (VW)**, producing departments are those that work directly on the products being manufactured (e.g., assembly and painting). **Support departments** provide essential services for producing departments. These departments are indirectly connected with an organization's services or products. At VW, those departments might include engineering, maintenance, personnel, and building and grounds.

Imperial Parking of Vancouver, B.C., with over 2,000 locations and 3,700 employees, has gathered together a number of its support departments to form a shared service centre (SSC). The SSC performs activities that are used across a wide array of the company's departments. Payroll, customer billing, and accounts receivable processing are examples of SCC "components". The company reaps the savings from economies of scale and standardized process design. Tools to measure performance are also incorporated into the SSC design. The SSC faces three important cost questions:

1. What causes costs in our operation?
2. How much should be charged back to the customers/producing departments?
3. How do our costs compare with those of outsourcing firms that perform the same service?

The drivers used to develop charging rates are seldom unit-based drivers (based on production). Instead, they might include the number of transactions processed and the percentage of errors in customer-provided information. Because activity-based costing (ABC) provides a better understanding of costs and their related drivers, it provides a better framework for managing SSC costs than traditional cost accounting systems.[1]

Once the producing and support departments have been identified, the overhead costs traceable to each department can be determined. A factory cafeteria, for example, would have food costs, wages of cooks and servers, depreciation on dishwashers and stoves, and supplies (e.g., napkins and plastic forks). Overhead directly associated with a producing department, such as assembly in a furniture-making plant, would include supplies used by that department, supervisory salaries, and depreciation on departmental equipment. Overhead that cannot be easily assigned to a producing or support department is assigned to a catchall department such as general factory. General factory might include depreciation on the factory building, rental of a Santa Claus suit for the factory Christmas party, the cost of restriping the parking lot, the plant manager's salary, and telephone service. In this way, all costs are assigned to a department.

Exhibit 7-1 shows how a manufacturing firm and a service firm can be divided into producing and support departments. The manufacturing plant, which makes furniture, may be departmentalized into two producing departments (Assembly and Finishing) and four support departments (Materials Storeroom, Cafeteria, Maintenance, and General Factory). The service firm, a bank, might be departmentalized into three producing departments (Auto Loans, Commercial Lending, and Personal Banking) and three support departments (Drive Through, Data Processing, and Bank

[1] Ann Triplett and Jon Scheumann, "Managing Shared Services with ABM," *Strategic Finance* (February 2000): 40–45. (adapted)

Exhibit 7-1

Examples of Departmentalization for a Manufacturing Firm and a Service Firm

Manufacturing Firm: Furniture Maker	
Producing Departments	**Support Departments**
Assembly:	Materials Storeroom:
Supervisors' salaries	Clerk's salary
Small tools	Depreciation on forklift
Indirect materials	Cafeteria:
Depreciation on machinery	Food
Finishing:	Cooks' salaries
Sandpaper	Depreciation on stoves
Depreciation on sanders and buffers	Maintenance:
	Janitors' salaries
	Cleaning supplies
	Machine oil and lubricants
	General Factory:
	Depreciation on building
	Security
	Utilities

Service Firm: Bank	
Producing Departments	**Support Departments**
Auto Loans:	Drive Through:
Loan processors' salaries	Tellers' salaries
Forms and supplies	Depreciation on equipment
Commercial Lending:	Data Processing:
Lending officers' salaries	Personnel salaries
Depreciation on office equipment	Software
Bankruptcy prediction software	Depreciation on hardware
Personal Banking:	Bank Administration:
Supplies and postage for statements	Salary of CEO
	Receptionist's salary
	Telephone costs
	Depreciation on bank and vault

Administration). Overhead costs are traced to each department. Note that each factory or service company overhead cost must be assigned to one, and only one, department.

Once the company is departmentalized and all overhead costs are traced to the individual departments, support department costs are assigned to producing departments, and overhead rates for the producing departments are developed to cost products. Although support departments do not work directly on the products or services that are sold, the costs of providing these support services are part of the total product cost and must be assigned to the products. This assignment of costs consists of a two-stage allocation: (1) allocation of support department costs to producing departments and (2) assignment of these allocated costs to individual products. The second-stage allocation, achieved through the use of departmental overhead rates, is necessary because there are multiple products being worked on in each producing department. If there were only one product within a producing department, all the support costs allocated to that department would belong to that product. Recall that a predetermined overhead rate is computed by taking total estimated overhead for a department and dividing it by an estimate of an appropriate allocation base. Now we see that a producing department's overhead consists of two parts: overhead directly associated with a producing department and overhead allocated to the producing department from the support departments. A support department cannot have an overhead rate that assigns overhead

Exhibit 7-2

Steps in Allocating Support Department Costs to Producing Departments

1. Departmentalize the firm.
2. Classify each department as a support department or a producing department.
3. Trace all overhead costs in the firm to a support or producing department.
4. Allocate support department costs to the producing departments.
5. Calculate predetermined overhead rates for producing departments.
6. Allocate overhead costs to the units of individual product through the predetermined overhead rates.

costs to units produced, because products are not produced in support departments. The nature of support departments is to service producing departments, not the products that pass through the producing departments. For example, maintenance personnel repair and maintain the equipment in the Assembly Department, not the furniture that is assembled in that department. Exhibit 7-2 summarizes the steps involved.

Types of Allocation Bases

In effect, producing departments *cause* support activities. **Causal factors** are variables or activities within a producing department that provoke the incurrence of support costs. In choosing a basis for allocating support department costs, appropriate causal factors (activity drivers) should be identified. Using causal factors results in more accurate product costs. Furthermore, if the causal factors are known, managers are more able to control the consumption of services.

To illustrate the types of causal factors, or activity drivers, that can be used, consider the following three support departments: Power, Personnel, and Materials Handling. For power costs, a logical allocation base is kilowatt-hours, which can be measured by separate metres for each department. If separate metres do not exist, perhaps machine hours used by each department would be a good proxy, or a means of approximating power usage. For personnel costs, both the number of producing department employees and the labour turnover (e.g., number of new hires) are possible activity drivers. For materials handling, the number of material moves, the hours of materials handling used, and the quantity of material moved are all possible activity drivers. Exhibit 7-3 lists some possible activity drivers for allocating support department costs. When competing activity drivers exist, managers choose the factor that is most easily measured and that provides the most convincing relationship.

Exhibit 7-3

Examples of Possible Activity Drivers for Support Departments

Accounting:
- Number of transactions

Cafeteria:
- Number of employees

Data Processing:
- Number of lines entered
- Number of hours of service

Engineering:
- Number of change orders
- Number of hours

Maintenance:
- Machine hours
- Maintenance hours

Materials Storeroom:
- Number of material moves
- Kilograms of material moved
- Number of different parts

Payroll:
- Number of employees

Personnel:
- Number of employees
- Number of firings or layoffs
- Number of new hires
- Direct labour cost

Power:
- Kilowatt-hours
- Machine hours

Purchasing:
- Number of orders
- Cost of orders

Shipping:
- Number of orders

While the use of a causal factor to allocate common cost is the best solution, sometimes an easily measured causal factor cannot be found. In that case, the accountant looks for a good proxy. For example, the common cost of plant depreciation may be allocated to producing departments on the basis of square metres. Though square metres do not cause depreciation, it can be argued that the number of square metres a department occupies is a good proxy for the services provided to it by the factory building. The choice of a good proxy to guide allocation is dependent upon the company's objectives for cost allocation.

Objectives of Cost Allocation

A number of important objectives are associated with the allocation of support department costs to producing departments and ultimately to specific products. The following major objectives have been identified by the IMA:[2]

1. To obtain a mutually agreeable price
2. To compute product-line profitability
3. To predict the economic effects of planning and control
4. To value inventory
5. To motivate managers

Competitive pricing requires a good understanding of costs. If costs are not accurately allocated, some costs could be overstated, resulting in prices, or bids, that are too high and a loss of potential business. Alternatively, if the costs are understated, bids could be too low, producing losses on these products.

Good estimates of individual product costs also allow managers to assess the profitability of individual products and services. Multiproduct companies need to be sure that all products are profitable and that the overall profitability of the firm is not disguising the poor performance of individual products. This meets the profitability objective identified by the IMA.

By assessing the profitability of various support services, a manager may evaluate the mix of support services offered by the firm. From this evaluation, executives may decide to drop some support services, reallocate resources from one to another, reprice certain support services, or exercise greater cost control in some areas. These steps would meet the IMA's planning and control objective.

For a service organization such as a law firm, the IMA objective of inventory valuation is not relevant. For manufacturing organizations, however, this objective requires special attention. Rules of financial reporting (GAAP) require that all direct and indirect manufacturing costs be assigned to the products produced. Since support department costs are indirect manufacturing costs, they must be assigned to products. This is accomplished through support department cost allocation. Inventories and cost of goods sold, then, include direct materials, direct labour, and all manufacturing overhead, including the cost of support departments.

Allocations can be used to motivate managers. If support department costs are not allocated to producing departments, managers tend to overuse these services. Consumption of a support service may continue until the marginal benefit of the service equals zero. Of course, the marginal cost of a service is greater than zero. By allocating the costs and holding managers of producing departments responsible for the economic performance of their units, the organization ensures that managers will use a support service until the marginal benefit of that service equals its marginal cost. Thus, allocation of support department costs helps each producing department select the correct level of support service use.

There are other behavioural benefits. Allocation of support department costs to producing departments encourages managers of those departments to monitor the performance of support departments. Since support department costs affect the economic performance of their own departments, those managers have an incentive to influence the

[2] *Statements of Management Accounting (Statement 4B)*, "Allocation of Service and Administrative Costs" (Montvale, NJ: NAA, 1985). The NAA is now known as the Institute of Management Accountants (IMA).

control over these costs through means other than simple usage of the support service. For instance, the managers can compare the internal costs of the support service with the costs of acquiring it externally. If a support department is not as cost effective as an outside source, perhaps the company should not continue to supply the service internally.

Many university libraries, for example, are moving toward the use of outside contractors for photocopying services. They have found that these contractors are more cost efficient and provide a higher level of service to library users than did the previous method of using professional librarians to make change, keep the copy machines supplied with paper, fix paper jams, etc.

Monitoring by managers of producing departments will also encourage managers of support departments to be more sensitive to the needs of the producing departments.

Clearly, there are good reasons for allocating support department costs. The validity of these reasons depends, however, on the accuracy and fairness of the cost assignments made. Although it may not be possible to identify a single method of allocation that simultaneously satisfies all of these objectives, several guidelines have been developed to assist in determining the best allocation method. These guidelines are cause and effect, benefits received, fairness, and ability to bear. Another guideline to be used in conjunction with any of the others is cost–benefit. That is, the method used must provide sufficient benefits to justify any effort involved.

Cause and effect requires the determination of causal factors to guide allocation. For example, a corporate legal department may track the number of hours spent on legal work for its various divisions (e.g., handling patent applications, lawsuits, etc.). The number of hours worked by lawyers and paralegals has a clear cause-and-effect relationship with the overall cost of the Legal Department and may be used to allocate these costs to the various company divisions.

The benefits-received guideline associates the cost with perceived benefits. Research and development (R&D) costs, for example, may be allocated on the basis of the sales of each division. While some R&D efforts may be unsuccessful and the successful efforts may happen to benefit one division in one year, all divisions have a stake in corporate R&D and will at some point have increased sales because of it.

Fairness or equity is a guideline often mentioned in government contracting. In the case of cost allocation methods, fairness usually means that the government contract should be costed in a method similar to that for nongovernmental contracts. For example, an airplane engine manufacturer may allocate a portion of corporate Legal Department costs to the government contract if these costs are usually allocated to private contracts.

Ability to bear is the least desirable guideline. It tends to "penalize" the most profitable division by allocating to it the largest proportion of a support department cost—regardless of whether the profitable division receives any services from the allocated department. This is why no motivational benefits of allocation are realized.

In determining how to allocate support department costs, the guideline of cost-benefit must be considered. In other words, the costs of implementing a particular allocation scheme must be compared to the benefits expected to be derived. This is why companies try to use easily measured and understood bases for allocation.

Allocating One Department's Costs to Other Departments

OBJECTIVE 2
Calculate charging rates, and distinguish between single and dual charging rates.

Frequently, the costs of a support department are allocated to other departments through the use of a charging rate. For example, a company's Data Processing Department may serve various other departments. The cost of operating the Data Processing Department is then allocated to the user departments. While this seems simple and straightforward, a number of considerations go into determining an appropriate charging rate. The two major factors are (1) the choice of a single or a dual charging rate and (2) the use of budgeted versus actual support department costs.

A Single Charging Rate

Some companies prefer to develop a single charging rate. This method is similar in concept to a plantwide overhead rate in that all support department costs are accumulated in the numerator and some measure of usage is in the denominator. There is only one rate, and it is relatively simple to apply. Suppose, for example, that Parminder and Murphy, a large regional public accounting firm, develops an in-house Photocopying Department to serve its three producing departments (Audit, Tax, and Management Advisory Services, or MAS). The firm wants to charge the using departments for their use of the photocopying service. Cornerstone 7-1 illustrates the calculation and use of the single charging rate when it is applied to budgeted amounts.

Under the single charging rate, the amount charged to the producing departments is based solely on the number of pages copied. Cornerstone 7-1 shows that the amount charged to the three using departments for their actual usage—272,000 pages copied—is $32,640. A single rate treats the fixed cost as if it were variable. In fact, to the producing departments, photocopying is strictly variable. Did the Photocopying Department need $32,640 to copy 272,000 pages? No, it needed only $32,446 [$26,190 + (272,000 × $0.023)]. The extra amount charged is due to the treatment of a fixed cost in a variable manner. Similarly, if the total number of pages is less than the amount budgeted, the single rate has the effect of undercompensating the Photocopying Department. Cornerstone 7-1 shows that if the actual pages copied had been 268,000, then $32,160 would be charged. However, the Photocopying Department needed $32,354 [$26,190 + (268,000 × $0.023)]. Again, the culprit is the treatment of fixed costs as if they were variable.

Multiple Charging Rates

Sometimes a single charging rate masks the variety of causal factors that lead to a support department's total costs. The Parminder and Murphy Photocopying Department is a good example. We saw that a single charging rate was based on the number of pages copied. Then, it looked like every page copied cost $0.12. But this is not true. A large portion of the costs of the Photocopying Department are fixed; they are not affected by the number of pages copied. Recall that $26,190 per year is spent on wages and rental of the photocopier. Why is this cost incurred? A talk with the photocopying company representative quickly yields the information that the size of the machine rented depends not on the number of pages copied per year, but on monthly peak usage. When Parminder and Murphy established the Photocopying Department, it surveyed the Audit, Tax, and MAS departments to determine each one's highest monthly usage. The Audit and MAS departments have fairly even copying needs throughout the year. The Tax Department, however, expects to need one-third of its yearly estimate in the month of April. Given this information, it appears that two charging rates are needed—one for variable costs based on the number of pages copied, and one for fixed costs based on estimated peak usage.

Developing a Variable Rate

The variable costs of the Photocopying Department are for paper and toner; these equal $0.023 per page. That is the variable rate to be used.

Developing a Fixed Rate

Fixed service costs are incurred to provide the capacity needed to deliver the service required by the producing departments. When the support department was established, its capacity was designed to serve the long-term needs of the producing departments. Since the original support needs caused the creation of the support service capacity, it seems reasonable to allocate fixed costs based on those needs.

The HOW and WHY of Calculating and Using a Single Charging Rate

CORNERSTONE 7-1

Information:

The expected (budgeted) cost of Parminder and Murphy's Photocopying Department for the coming year include:

Fixed costs (machine rental, salaries): $26,190 per year
Variable costs (paper and toner): $0.023 per page copied

Estimated (budgeted) usage by:

Audit Department	94,500
Tax Department	67,500
MAS Department	108,000
Total pages	270,000

Actual usage by:

Audit Department	92,000
Tax Department	65,000
MAS Department	115,000
Total pages	272,000

Why:

Many companies want to charge the costs of using support departments to the using departments. This makes the using departments responsible for their usage and helps prevent overuse of resources.

Required:

1. Calculate a single charging rate for the Photocopying Department.
2. Use this rate to assign the costs of the Photocopying Department to the user departments based on actual usage. Calculate the total amount charged for photocopying for the year.
3. ***What if*** the Audit and Tax departments used 92,000 and 65,000 pages, respectively, but the MAS Department only used 111,000 pages? How much would have been charged out to the three departments?

Solution:

1. Total expected costs of the Photocopying Department:

Fixed costs	$26,190
Variable costs ($0.023 × 270,000 pages)	6,210
Total costs	$32,400

Single charging rate = $32,400/270,000 = $0.12 per page

2. Charge based on actual usage = Charging rate × Actual pages

Audit Department charge = $0.12 × 92,000 = $11,040
Tax Department charge = $0.12 × 65,000 = $7,800
MAS Department charge = $0.12 × 115,000 = $13,800
Total amount charged = $11,040 + $7,800 + $13,800
= $32,640

CORNERSTONE 7-1 *(continued)*

3. Audit Department charge = $0.12 × 92,000 = $11,040
   Tax Department charge = $0.12 × 65,000 = $7,800
   MAS Department charge = $0.12 × 111,000 = $13,320
   Total amount charged = $11,040 + $7,800 + $13,320
   = $32,160

Either the normal or peak activity of the producing departments provides a reasonable measure of original support service needs. Normal capacity is the average capacity achieved over more than one fiscal period. If service is required uniformly over the time period, normal capacity is a good measure of activity. Peak capacity allows for variation in the need for the support department, and the size of the department is structured to allow for maximum need. In our example, the Tax Department may need much more photocopying during the first four months of the year, and its usage may be based on that need. The choice of normal or peak capacity in allocating budgeted fixed service costs depends on the needs of the individual firm. Budgeted fixed costs are allocated in this way regardless of whether the purpose is product costing or performance evaluation.

The allocation of fixed costs follows a three-step procedure:

1. *Determination of budgeted fixed support service costs.* The fixed support service costs that should be incurred for a period need to be identified.
2. *Computation of the allocation ratio.* The practical or normal capacity of each producing department is used to compute an allocation ratio. The allocation ratio gives a producing department's share or percentage of the total capacity of all producing departments.

   Allocation ratio = Producing department capacity/Total capacity

3. *Allocation.* The fixed support service costs are allocated in proportion to each producing department's original support service needs.

   Allocation = Allocation ratio × Budgeted fixed support service costs

Cornerstone 7-2 shows how and why to calculate two charging rates—one for the variable costs of the support department, and the other rate for the fixed costs.

Total Allocation Under the dual charging rates, the fixed photocopying rates are charged to the departments in accordance with their original capacity needs. Especially in a case like the Photocopying Department example, in which fixed costs are such a high proportion of total costs, the additional effort needed to develop the dual rates may be worthwhile.

Comparing Cornerstone 7-1 results with those of Cornerstone 7-2, we see that the allocation of Photocopying Department costs is very different when the two charging rates are used. In this case, the Tax Department absorbs a larger proportion of the cost, because its peak usage is responsible for the size of the department. Notice, too, that the total amount charged of $32,446 is very close to the actual cost of running the department. With the two charging rates, each based on a strong causal factor, the allocation of cost to the using departments is close to the amount of cost that they actually cause the support department. The development of dual charging rates (which are used as the basis for pricing) is particularly important in companies such as public utilities.

The dual-rate method has the benefit of sending the correct signal regarding increased usage of the support department. Suppose that the Tax Department wants to have several research articles on tax law changes photocopied for clients. Should this be done "in house" by the Photocopying Department or sent to a private photocopying firm

The HOW and WHY of Calculating and Using Multiple Charging Rates

CORNERSTONE 7-2

Information:

The expected (budgeted) cost of Parminder and Murphy's Photocopying Department for the coming year include:

Fixed costs (machine rental, salaries): $26,190 per year
Variable costs (paper and toner): $0.023 per page copied

The Audit and MAS departments expect to use photocopying services evenly throughout the year. The Tax Department expects that one-third of its annual usage will occur in April.

Estimated (budgeted) usage:

	Yearly Pages	Monthly Peak Pages
Audit Department	94,500	7,875
Tax Department	67,500	22,500
MAS Department	108,000	9,000
Total pages	270,000	39,375

Actual usage in year:

Audit Department	92,000
Tax Department	65,000
MAS Department	115,000
Total pages	272,000

Why:

Two rates are calculated; the variable rate is based on number of pages and the fixed rate is based on peak usage. These rates more accurately assign support department costs to the using departments.

Required:

1. Calculate a variable rate for the Photocopying Department. Calculate the allocated fixed cost for each using department based on its budgeted monthly peak usage in pages.
2. Use the two rates to assign the costs of the Photocopying Department to the user departments based on actual usage. Calculate the total amount charged for photocopying for the year.
3. ***What if*** the Audit and Tax departments actually used 92,000 and 65,000 pages, respectively, but the MAS Department only used 111,000 pages? How much would have been charged out to the three departments?

Solution:

1. Variable rate = $0.023 per page

   The fixed allocation is calculated for each department based on budgeted monthly peak usage. Monthly peak usage for Audit and MAS is one-twelfth of the yearly amount. The monthly peak usage for Tax is one-third of the yearly amount (the amount for April). The allocation is given in the following table:

CORNERSTONE 7-2 *(continued)*

Department	Peak Number of Copies	Percent*	Budgeted Fixed Cost	Allocated Fixed Cost
Audit	7,875	20%	$26,190	$ 5,238
Tax	22,500	57	26,190	14,928
MAS	9,000	23	26,190	6,024
Total	39,375	100%		$26,190

*Percent for Audit = $7,875/$39,375 = 0.20, or 20%
Percent for Tax = $22,500/$39,375 = 0.57, or 57% (rounded)
Percent for MAS = $9,000/$39,375 = 0.23, or 23% (rounded)

2.

Department	Actual Number of Copies	Variable Rate	Variable Amount	Fixed Amount	Total Charge
Audit	92,000	$0.023	$2,116	$ 5,238	$ 7,354
Tax	65,000	0.023	1,495	14,928	16,423
MAS	115,000	0.023	2,645	6,024	8,669
Total	272,000		$6,256	$26,190	$32,446

3.

Department	Actual Number of Copies	Variable Rate	Variable Amount	Fixed Amount	Total Charge
Audit	92,000	$0.023	$2,116	$ 5,238	$ 7,354
Tax	65,000	0.023	1,495	14,928	16,423
MAS	111,000	0.023	2,553	6,024	8,577
Total	268,000		$6,164	$26,190	$32,354

that charges $0.06 per page? Under the single-rate method, the in-house charge would be too high because it wrongly assumes that fixed cost will increase as pages copied increase. However, under the dual-rate method, the additional cost would be only $0.023 per page, which correctly approximates the additional cost of the job.

Could there be more than two charging rates? Definitely. However, as a company breaks down support department resources and causal factors more finely, it may be approaching activity-based costing. The extra precision of charging rates must be balanced against the cost of determining and applying those rates. As always, the company must consider costs and benefits.

Budgeted versus Actual Usage

In Cornerstones 7-1 and 7-2, the allocation bases for determining the charging rates were based on budgeted amounts, not actual amounts. This is valuable for two reasons. First, the use of budgeted data permits producing departments to use the support department allocations in developing overhead rates that are used for product or service costing. Recall that the overhead rate is calculated at the beginning of the period, when actual costs are unknown. Thus, budgeted costs must be used. The second usage of allocated support department costs is for performance evaluation. In this case, too, budgeted support department costs are allocated to producing departments.

Managers of support and producing departments usually are held accountable for the performance of their departments. Their ability to control costs is an important factor in their performance evaluations. This ability is usually measured by comparing actual costs with planned or budgeted costs. If actual costs exceed budgeted costs, the department may be operating inefficiently, with the difference between the two costs serving as the measure of that inefficiency. Similarly, if actual costs are less than budgeted costs, the department may be operating efficiently.

A general principle of performance evaluation is that managers should be held responsible for costs or activities over which they have control. Since managers of producing departments have significant input regarding the level of support service consumed, they should be held responsible for their share of support service costs. This statement, however, has an important qualification: A department's evaluation should not be affected by the degree of efficiency achieved by another department.

This qualifying statement has an important implication for the allocation of support department costs. *Actual* costs of a support department should not be allocated to producing departments because they may include efficiencies or inefficiencies achieved by the support department. Managers of producing departments do not control the degree of efficiency achieved by a support department manager. When *budgeted* costs are allocated instead of actual costs, no inefficiencies or efficiencies are transferred from one department to another.

Whether budgeted usage or actual usage is employed depends on the purpose of the allocation. For *product costing*, the allocation is done at the beginning of the year on the basis of budgeted usage so that a predetermined overhead rate can be computed. If the purpose is *performance evaluation*, however, the allocation is done at the end of the period and is based on actual usage. The use of cost information for performance evaluation is covered in more detail in Chapter 9.

Let's return to our photocopying example. Recall that annual budgeted fixed costs were $26,190 and the budgeted variable cost per page was $0.023. The three producing departments—Audit, Tax, and MAS—estimated usage at 94,500 copies, 67,500 copies, and 108,000 copies, respectively. Given these data, the costs allocated to each department at the *beginning* of the year are shown in Exhibit 7-4.

Exhibit 7-4

Use of Budgeted Data for Product Costing: Comparison of Single- and Dual-Rate Methods

Single-Rate Method

	Number of Copies	×	Total Rate	=	Allocated Cost
Audit	94,500		$0.12		$11,340
Tax	67,500		0.12		8,100
MAS	108,000		0.12		12,960
Total	270,000				$32,400

Dual-Rate Method

	Number of Copies	×	Variable Rate	+	Fixed Allocation	=	Allocated Cost
Audit	94,500		$0.023		$ 5,238		$ 7,411*
Tax	67,500		0.023		14,928		16,481*
MAS	108,000		0.023		6,024		8,508
Total	270,000						$32,400

*Rounded.

When the allocation is done for the purpose of budgeting the producing departments' costs, then, of course, the budgeted support department costs are used. The photocopying costs allocated to each department would be added to other producing department costs—including those directly traceable to each department plus other support department allocations—to compute each department's anticipated spending. In a manufacturing plant, the allocation of budgeted support department costs to the producing departments would precede the calculation of the predetermined overhead rate.

During the year, each producing department would also be responsible for actual charges incurred based on the actual number of pages copied. Going back to the actual usage assumed previously, a second allocation is now made to measure the actual performance of each department against its budget. The actual photocopying costs allocated to each department for performance evaluation purposes are shown in Exhibit 7-5.

Fixed versus Variable Bases: A Note of Caution

Using normal or practical capacity to allocate fixed support service costs provides a *fixed* base. As long as the capacities of the producing departments remain at the original level, there is no reason to change the allocation ratios. Thus, each year, the Audit Department receives 35 percent of the budgeted fixed photocopying costs, the Tax Department 25 percent, and the MAS Department 40 percent, no matter what their actual usage is. If the capacities of the departments change, the ratios should be recalculated.

In practice, some companies choose to allocate fixed costs in proportion to actual usage or expected actual usage. Since usage may vary from year to year, allocation of fixed costs would then use a variable base. Variable bases, however, have a significant drawback: they allow the actions of one department to affect the amount of cost allocated to another department.

To see how this is demonstrated, let's return to Parminder and Murphy's Photocopying Department and assume that fixed costs are allocated on the basis of anticipated usage for the coming year. The Audit and Tax departments budget the same number of copies as before. However, the MAS Department anticipates much less activity due to a regional recession, which will cut down the number of new clients served; the anticipated number of photocopies for this department falls to 68,000. The adjusted fixed cost allocation ratios and allocated fixed cost based on the newly budgeted usage are as follows:

Department	Number of Copies	Percent	Allocated Fixed Cost
Audit	94,500	41.1%	$10,764
Tax	67,500	29.3	7,674
MAS	68,000	29.6	7,752
Total	230,000	100.0%	$26,190

Notice that both the Audit and Tax departments' allocation of fixed costs increased even though the fixed costs of the Photocopying Department remained unchanged. This increase was caused by a decrease in the MAS Department's use of photocopying. In effect, the Audit and Tax departments have been penalized by MAS's decision to reduce the number of pages copied for its department. Imagine the feelings of the first two managers when they realize that their copying charges have increased due to the increase in allocated fixed costs! The penalty occurs because a variable base has been used to allocate fixed support service costs; this can be avoided by using a fixed base.

Exhibit 7-5

Use of Actual Data for Performance Evaluation Purposes: Comparison of Single- and Dual-Rate Methods

Single-Rate Method

	Number of Copies	×	Total Rate	=	Allocated Cost
Audit	92,000		$0.12		$11,040
Tax	65,000		0.12		7,800
MAS	115,000		0.12		13,800
Total	272,000				$32,640

Dual-Rate Method

	Number of Copies	×	Variable Rate	+	Fixed Allocation	=	Allocated Cost
Audit	92,000		$0.023		$ 5,238		$ 7,354
Tax	65,000		0.023		14,928		16,423
MAS	115,000		0.023		6,024		8,669
Total	272,000						$32,446

Allocating Multiple Support Department Costs to Other Departments

OBJECTIVE 3

Allocate support centre costs to producing departments using the direct method, the sequential method, and the reciprocal method.

So far, we have considered cost allocation from a single support department to several producing departments. We used the direct method of support department cost allocation, in which support department costs are allocated only to producing departments. This was appropriate in the earlier example because no other support departments existed. This would also be appropriate when there is no possibility of interaction among support departments. Many companies do have multiple support departments and they frequently interact. For example, in a factory, Personnel and Cafeteria serve each other, other support departments, and the producing departments.

Ignoring these interactions and allocating support costs directly to producing departments may produce unfair and inaccurate cost assignments. For example, Power, although a support department, may use 30 percent of the services of the Maintenance Department. The maintenance costs caused by the Power Department belong to the Power Department. When these costs are not assigned to the Power Department, its costs are understated. In effect, some of the costs caused by Power are "hidden" in the Maintenance Department because maintenance costs would be lower if the Power Department did not exist. As a result, a producing department that is a heavy user of power and an average or below-average user of maintenance may then receive, under the direct method, a cost allocation that is understated.

In determining which support department cost allocation method to use, companies must determine the extent of support department interaction. In addition, they must weigh the costs and benefits associated with the three methods described and illustrated in the following sections: the direct, sequential, and reciprocal methods. Exhibit 7-6 presents data for a factory with two support departments—Power and Maintenance, and two producing departments—Grinding and Assembly. The activity drivers for the support departments are kilowatt-hours (for Power) and maintenance hours (for Maintenance). The direct overhead costs for each department are listed first. For the support departments, direct overhead costs include all costs of running the support departments. For the producing departments, the direct overhead costs are those overhead costs that are traced directly to those departments such as supervisory salaries and equipment depreciation. A final point should be

Exhibit 7-6

Data for Support and Producing Departments

	Support Departments		Producing Departments	
	Power	Maintenance	Grinding	Assembly
Direct costs	$250,000	$160,000	$100,000	$ 60,000
Normal activity:				
Kilowatt-hours	—	200,000	600,000	200,000
Maintenance hours	1,000	—	4,500	4,500

made regarding the dashes for kilowatt-hours for Power and for maintenance hours for Maintenance. Doesn't the Power Department use power? Absolutely, however, it does not matter how many kilowatt-hours are used by Power for the purposes of allocating Power Department cost. Similarly for Maintenance, for allocation purposes, it does not matter how many hours the Maintenance Department spends on maintaining its own department.

Direct Method of Allocation

When companies allocate support department costs only to the producing departments, they are using the **direct method** of allocation. The direct method is the simplest and most straightforward way to allocate support department costs. All costs of the support departments are allocated directly to producing departments in proportion to each producing department's usage of the service. This method does not allocate any support department costs to another support department, even if other support departments use the services of a support department. This usage of one support department by another is called support department reciprocity. Under the direct method, no support department reciprocity or interaction is recognized.

Cornerstone 7-3 shows how and why to allocate support department costs to producing departments using the direct method.

Examine Cornerstone 7-3 carefully. Notice that Requirement 1 shows how to calculate the allocation ratios. Since no support department cost is allocated to another support department, there are no percentages shown for Power or Maintenance. All of the support department output is assigned to the producing departments. In Requirement 2, the costs of Power and Maintenance are allocated to the producing departments. We see that all cost in each support department is divided up between the producing departments. Once those costs are allocated, there is zero cost remaining in the support departments.

Finally, it is a good idea to check the pre-and post-allocation totals. Before allocation, the total overhead in the factory is $570,000 ($250,000 + $160,000 + $100,000 + $60,000). After allocation is complete, total factory overhead is still $570,000 ($367,500 + $202,500). These totals will always be the same (except for rounding error). Allocation does not increase or decrease total overhead, it just redistributes it to the producing departments.

Sequential Method of Allocation

The **sequential (or step) method** of allocation recognizes that interactions among the support departments do occur; however, the sequential method takes only partial account of this interaction. Cost allocations are performed in step-down fashion, following a predetermined ranking procedure. This ranking can be performed in various ways. One possibility is to rank the support departments in order of the percentage of service provided to other support departments. Another possibility is to rank the support departments in order of their total cost, from highest cost department to lowest.

Once the support departments have been ranked, the top ranking department is allocated to lower ranking support departments and the producing departments. It is then closed out (has a total cost remaining of zero) and the remaining support departments cannot allocate cost back to it. Then, the costs of the support

The HOW and WHY of Allocating Support Department Costs to Producing Departments Using the Direct Method

CORNERSTONE 7-3

Information:

Refer to Exhibit 7-6 for data on the two support and two producing departments. The costs of the Power Department are allocated on the basis of kilowatt-hours, and the costs of the Maintenance Department are allocated on the basis of maintenance hours. The factory uses the direct method of support department cost allocation.

Why:

Support department costs must be allocated to the producing departments so that the producing departments can calculate their overhead rates. The direct method is simple and easy to use. If there is relatively little support department reciprocity, it does a fairly good job.

Required:

1. Calculate the allocation ratios for the four departments using the direct method.
2. Using the direct method, allocate the costs of the Power and Maintenance departments to the Grinding and Assembly departments.
3. ***What if*** the Maintenance Department used only 100,000 kilowatt-hours? How would that affect the allocation of Power Department costs to the Grinding and Assembly departments?

Solution:

1. Allocation ratios:

	Proportion of Driver Used by			
	Power	**Maintenance**	**Grinding**	**Assembly**
Power	—	—	0.75[1]	0.25[2]
Maintenance	—	—	0.50[3]	0.50[4]

[1] Proportion of kilowatt-hours used by Grinding = 600,000/(600,000 + 200,000) = 0.75
[2] Proportion of kilowatt-hours used by Assembly = 200,000/(600,000 + 200,000) = 0.25
[3] Proportion of maintenance hours used by Grinding = 4,500/(4,500 + 4,500) = 0.50
[4] Proportion of maintenance hours used by Assembly = 4,500/(4,500 + 4,500) = 0.50

2.

	Support Departments		Producing Departments	
	Power	**Maintenance**	**Grinding**	**Assembly**
Direct costs	$ 250,000	$ 160,000	$100,000	$ 60,000
Allocate:				
Power[1]	(250,000)	—	187,500	62,500
Maintenance[2]	—	(160,000)	80,000	80,000
Total after allocation	$ 0	$ 0	$367,500	$202,500

[1] Grinding = 0.75 × $250,000 = $187,500; Assembly = 0.25 × $250,000 = $62,500
[2] Grinding = 0.50 × $160,000 = $80,000; Assembly = 0.50 × $160,000 = $80,000

3. Since none of the Power cost is allocated to Maintenance, it does not matter how many kilowatt-hours are used by Maintenance.

department next in sequence are similarly allocated, and so on. In the sequential method, once a support department's costs are allocated, it never receives a subsequent allocation from another support department. In other words, costs of a support department are never allocated to support departments *above* it in the sequence. Also note that the costs allocated from a support department are its direct costs *plus* any costs it receives in allocations from other support departments. The direct costs of a department are those that are directly traceable to the department.

Cornerstone 7-4 shows how and why to use the sequential method. The data originally given in Exhibit 7-6 are used. First, the support departments are ranked. Power provides relatively more service to Maintenance than Maintenance provides to Power. In addition, the cost of Power is higher than the cost of Maintenance. So, no matter which ranking system is used, Power is allocated first, then Maintenance.

As before, it is a good idea to check the pre- and post-allocation totals. Before allocation, the total overhead in the factory is $570,000 ($250,000 + $160,000 + $100,000 + $60,000). After allocation is complete, total factory overhead is $570,000 ($355,000 + $215,000). These totals will always be the same (except for rounding error). Allocation does not increase or decrease total overhead, it just redistributes it to the producing departments.

The sequential method may be more accurate than the direct method because it recognizes some interactions among the support departments. It does not recognize all interactions, however; no maintenance costs were assigned to the Power Department even though it used 10 percent of the Maintenance Department's output. The reciprocal method corrects this deficiency, as we will see later.

Reciprocal Method of Allocation

The **reciprocal method** of allocation recognizes all interactions of support departments. Under the reciprocal method, the usage of one support department by another is used to determine the total cost of each support department, where the total cost reflects interactions among the support departments. Then, the new total of support department costs is allocated to the producing departments. This method fully accounts for support department interaction.

Total Cost of Support Departments

To determine the total cost of a support department so that this total cost reflects interactions with other support departments, a system of simultaneous linear equations must be solved. Each equation, which is a cost equation for a support department, is the sum of the department's direct costs plus the proportion of service received from other support departments.

$$\text{Total cost} = \text{Direct costs} + \text{Allocated costs}$$

The same data set contained in Exhibit 7-6 used to illustrate the direct and sequential methods will be used to illustrate the reciprocal method. Cornerstone 7-5 shows how and why the reciprocal method is used to allocate support department costs.

As Cornerstone 7-5 shows, the steps for the reciprocal method are:

1. Compute the allocation ratios for all support and producing departments.
2. Form a simultaneous equations system with one equation for each support department. The interpretation of each equation is that the total reciprocated cost of the support department equals its original cost plus any cost that it imposes on any other support departments.
3. Solve the simultaneous equations system for each unknown to obtain the total reciprocated cost of each support department.
4. Allocate the total reciprocated costs of the support departments to other support departments and to the producing departments based on the allocation ratios developed in Step 1.

The HOW and WHY of Allocating Support Department Costs to Producing Departments Using the Sequential (Step) Method

CORNERSTONE 7-4

Information:

Refer to Exhibit 7-6 for data on the two support and two producing departments. The costs of the Power Department are allocated on the basis of kilowatt-hours, and the costs of the Maintenance Department are allocated on the basis of maintenance hours. The factory uses the sequential method of support department cost allocation.

Why:

Support department costs must be allocated to the producing departments so that the producing departments can calculate their overhead rates. The sequential method takes some account of support department reciprocity and is, therefore, somewhat better than the direct method.

Required:

1. Calculate the allocation ratios for the four departments using the sequential method.
2. Using the sequential method, allocate the costs of the Power and Maintenance departments to the Grinding and Assembly departments.
3. ***What if*** the Maintenance Department used only 100,000 kilowatt-hours? How would that affect the allocation of Power Department costs to the Grinding and Assembly departments?

Solution:

1. Power is allocated first because 20 percent of its service [200,000/(200,000 + 600,000 + 200,000) = 20%] is used for other support departments (in this case, Maintenance). Only 10 percent [1,000/(1,000 + 4,500 + 4,500) = 10%] of Maintenance services are used by other support departments (i.e., Power).

   Allocation ratios:

	Proportion of Driver Used by			
	Power	**Maintenance**	**Grinding**	**Assembly**
Power	—	0.20[1]	0.60[2]	0.20[3]
Maintenance	—	—	0.50[4]	0.50[5]

[1] Proportion of kilowatt-hours used by Maintenance = 200,000/(200,000 + 600,000 + 200,000) = 0.20
[2] Proportion of kilowatt-hours used by Grinding = 600,000/(200,000 + 600,000 + 200,000) = 0.60
[3] Proportion of kilowatt-hours used by Assembly = 200,000/(200,000 + 600,000 + 200,000) = 0.20
[4] Proportion of maintenance hours used by Grinding = 4,500/(4,500 + 4,500) = 0.50
[5] Proportion of maintenance hours used by Assembly = 4,500/(4,500 + 4,500) = 0.50

2.

	Support Departments		Producing Departments	
	Power	**Maintenance**	**Grinding**	**Assembly**
Direct costs	$ 250,000	$ 160,000	$100,000	$ 60,000
Allocate:				
Power[1]	(250,000)	50,000	150,000	50,000
Maintenance[2]	—	(210,000)	105,000	105,000
Total after allocation	$ 0	$ 0	$355,000	$215,000

[1] Maintenance = 0.2 × $250,000 = $50,000; Grinding = 0.60 × $250,000 = $150,000; Assembly = 0.20 × $250,000 = $50,000
[2] Grinding = 0.50 × ($160,000 + $50,000) = $105,000; Assembly = 0.50 × ($160,000 + $50,000) = $105,000

CORNERSTONE 7-4 *(continued)*

3. If Maintenance used only 100,000 kilowatt-hours, then the proportion of service it uses would drop to 11.11% [100,000/(100,000 + 600,000 + 200,000)]. Power would still be allocated first; however, the allocation ratios for Power would change to: Maintenance, 11.11%; Grinding, 66.67%; and Assembly, 22.22% (rounded). Thus, relatively fewer dollars would be allocated to Maintenance, and relatively more to Grinding and Assembly. The new allocations would be as follows:

	Support Departments		Producing Departments	
	Power	Maintenance	Grinding	Assembly
Direct costs	$ 250,000	$ 160,000	$100,000	$ 60,000
Allocate:				
Power[1]	(250,000)	27,775	166,675	55,550
Maintenance[2]	—	(187,775)	93,888	93,887*
Total after allocation	$ 0	$ 0	$360,563	$209,437

[1] Maintenance = 0.1111 × $250,000 = $27,775; Grinding = 0.6667 × $250,000 = $166,675; Assembly = 0.2222 × $250,000 = $55,550
[2] Grinding = 0.50 × ($160,000 + $27,775) = $93,887; Assembly = 0.50 × ($160,000 + $27,775) = $93,887*
* rounded

After the equations are solved, the total costs of each support department are known. These total costs, unlike the direct or sequential methods, reflect all interactions between support departments. As a result, the reciprocal method is the best method in terms of accounting for all interactions among the support departments.

Comparison of the Three Cost Allocation Methods

Exhibit 7-7 gives the cost allocations from the Power and Maintenance departments to the Grinding and Assembly departments using the three support department cost allocation methods. How different are the results? Does it really matter which method is used? Depending on the degree of support department interaction, the three allocation methods can give quite different results. In this particular example, the direct method (as compared to the sequential method) allocated $12,500 more to the Grinding Department (and $12,500 less to the Assembly Department). Surely, the manager of the Assembly Department would prefer the direct method, and the manager of the Grinding Department would prefer the sequential method. Because allocation methods do affect the cost responsibilities of managers, it is important for

Exhibit 7-7

Comparison of Support Department Cost Allocations Using the Direct, Sequential, and Reciprocal Methods

	Direct Method		Sequential Method		Reciprocal Method	
	Grinding	Assembly	Grinding	Assembly	Grinding	Assembly
Direct costs	$100,000	$ 60,000	$100,000	$ 60,000	$100,000	$ 60,000
Allocated from power	187,500	62,500	150,000	50,000	162,857	54,285
Allocated from maintenance	80,000	80,000	105,000	105,000	96,429	96,429
Total cost	$367,500	$202,500	$355,000	$215,000	$359,286	$210,714

The HOW and WHY of Allocating Support Department Costs to Producing Departments Using the Reciprocal Method

CORNERSTONE 7-5

Information:

Refer to Exhibit 7-6 for data on the two support and two producing departments. The costs of the Power Department are allocated on the basis of kilowatt-hours, and the costs of the Maintenance Department are allocated on the basis of maintenance hours. The factory uses the reciprocal method of support department cost allocation.

Why:

Support department costs must be allocated to the producing departments so that the producing departments can calculate their overhead rates. The reciprocal method takes full account of support department reciprocity and is, therefore, the theoretically best method.

Required:

1. Calculate the allocation ratios for the four departments in preparation for the reciprocal method.
2. Develop a simultaneous equations system of total costs for the support departments. Solve for the total reciprocated costs of each support department.
3. Using the reciprocal method, allocate the fully reciprocated costs of the Power and Maintenance departments to the Grinding and Assembly Departments.
4. ***What if*** the Maintenance Department used only 100,000 kilowatt-hours? How would that affect the allocation of Power Department costs to the Grinding and Assembly departments?

Solution:

1. Allocation ratios:

	Proportion of Driver Used by			
	Power	**Maintenance**	**Grinding**	**Assembly**
Power	—	0.20[1]	0.60[2]	0.20[3]
Maintenance	0.10[4]	—	0.45[5]	0.45[6]

[1] Proportion of kilowatt-hours used by Maintenance = 200,000/(200,000 + 600,000 + 200,000) = 0.20
[2] Proportion of kilowatt-hours used by Grinding = 600,000/(200,000 + 600,000 + 200,000) = 0.60
[3] Proportion of kilowatt-hours used by Assembly = 200,000/(200,000 + 600,000 + 200,000) = 0.20
[4] Proportion of maintenance hours used by Power = 1,000/(1,000 + 4,500 + 4,500) = 0.10
[5] Proportion of maintenance hours used by Grinding = 4,500/(1,000 + 4,500 + 4,500) = 0.45
[6] Proportion of maintenance hours used by Assembly = 4,500/(1,000 + 4,500 + 4,500) = 0.45

2. Let P = Fully reciprocated costs for Power; and
   M = Fully reciprocated costs for Maintenance

$$P = \$250,000 + 0.1M$$
$$M = \$160,000 + 0.2P$$

Solve for P by substituting ($160,000 + 0.2$P$) for M:

$$P = \$250,000 + 0.1(\$160,000 + 0.2P)$$
$$P - 0.02P = \$250,000 + \$16,000$$
$$0.98P = \$266,000$$
$$P = \$271,429 \text{ (rounded)}$$

CORNERSTONE 7-5 *(continued)*

Solve for *M:*

$M = \$160{,}000 + 0.2(\$271{,}429) = \$214{,}286$ (rounded)

3.

	Support Departments		Producing Departments	
	Power	**Maintenance**	**Grinding**	**Assembly**
Direct costs	$ 250,000	$ 160,000	$100,000	$ 60,000
Allocate:				
Power[1]	(271,429)	54,286	162,857	54,286*
Maintenance[2]	21,429	(214,286)	96,429	96,429
Total after allocation	$ 0	$ 0	$359,286	$210,714

[1] Maintenance = 0.20 × $271,429 = $54,286; Grinding = 0.60 × $271,429 = $162,857; Assembly = 0.20 × $271,429 = $54,286
[2] Power = 0.10 × $214,286 = $21,429; Grinding = 0.45 × $214,286 = $96,429; Assembly = 0.45 × $214,286 = $96,429
* rounded

4. If Maintenance used only 100,000 kilowatt-hours, then the proportion of service it uses would drop to 11.11% [100,000/(100,000 + 600,000 + 200,000)]. The allocation ratios for Power would change to: Maintenance, 11.11%; Grinding, 66.67%; and Assembly, 22.22% (rounded). This would affect the simultaneous equations and the subsequent allocation.

$$P = \$250{,}000 + 0.1M$$
$$M = \$160{,}000 + 0.1111P$$

Solve for *P* by substituting ($160,000 + 0.1111P) for *M:*

$$P = \$250{,}000 + 0.1(\$160{,}000 + 0.1111P)$$
$$P - 0.01111P = \$250{,}000 + \$16{,}000$$
$$0.98889P = \$266{,}000$$
$$P = \$268{,}989 \text{ (rounded)}$$

Solve for *M:*

$$M = \$160{,}000 + 0.1111(\$268{,}989) = \$189{,}885 \text{ (rounded)}$$

The new allocations would be as follows:

	Support Departments		Producing Departments	
	Power	**Maintenance**	**Grinding**	**Assembly**
Direct costs	$ 250,000	$ 160,000	$100,000	$ 60,000
Allocate:				
Power[1]	(268,989)*	29,885	179,335	59,769
Maintenance[2]	18,989	(189,885)	85,448	85,448
Total after allocation	$ 0	$ 0	$364,783	$205,217

[1] Maintenance = 0.1111 × $268,989 = $29,885; Grinding = 0.6667 × $268,989 = $179,335; Assembly = 0.2222 × $268,989 = $59,769
[2] Power = 0.10 × $189,885 = $18,989; Grinding = 0.45 × $189,885 = $85,448; Assembly = 0.45 × $189,885 = $85,448
* rounded

the accountant to understand the consequences of the different methods and to have good reasons for the eventual choice.

It is important to keep a cost–benefit perspective in choosing an allocation method. The accountant must weigh the advantages of better allocation against the increased cost using a more theoretically preferred method, such as the reciprocal method. For example, about 30 years ago, the controller for the **IBM** Poughkeepsie plant decided that the reciprocal method of cost allocation would do a better job of allocating support department costs. He identified over 700 support departments and solved the system of equations using a computer. Computationally, he had no problems. However, the producing department managers did not understand the reciprocal method. They were sure that extra cost was being allocated to their departments, but they were not sure just how. After months of meetings with the line managers, the controller threw in the towel and returned to the sequential method—which everyone did understand.[3]

Another factor to be considered in allocating support department cost is the rapid change in technology. Many firms currently find that support department cost allocation is useful for them. However, the move toward activity-based costing and just-in-time manufacturing can virtually eliminate the need for support department cost allocation. In the case of the JIT factory with manufacturing cells, much of the service (e.g., maintenance, materials handling, and setups) is performed by cell workers. Allocation is not necessary.

Departmental Overhead Rates and Product Costing

OBJECTIVE ➤ 4
Calculate departmental overhead rates.

Upon allocating all support service costs to producing departments, an overhead rate can be computed for each department. This rate is computed by adding the allocated service costs to the overhead costs that are directly traceable to the producing department and dividing this total by some measure of activity, such as direct labour hours or machine hours. Cornerstone 7-6 shows how and why to use the allocated support department costs to develop departmental overhead rates.

One might wonder, however, just how accurate are the job costs calculated in Cornerstone 7-6? Is this amount the true cost of the product in question? Since materials and labour are directly traceable to products, the accuracy of product costs depends largely on the accuracy of the assignment of overhead costs. This in turn depends on the degree of correlation between the factors used to allocate support service costs to departments and on the factors used to allocate the department's overhead costs to the products. For example, if power costs are highly correlated with kilowatt-hours and machine hours are highly correlated with a product's consumption of the Grinding Department's overhead costs, then we can have some confidence that the $5 overhead rate accurately assigns costs to individual products. However, if the allocation of support service costs to the Grinding Department or the use of machine hours is faulty—or both—then product costs will be distorted. The same reasoning can be applied to the Assembly Department. To ensure accurate product costs, great care should be used in identifying and using causal factors for both stages of overhead assignment. Activity-based costing, explained in Chapter 6, can be used to develop more accurate product costs.

Outsourcing Support Department Costs

Today many companies are examining the cost savings that might be obtained by outsourcing certain of their nonessential activities. Payroll services, computer systems operations, routine accounting functions, call centre operations, customer service functions, and other routine activities lend themselves to being provided by outside companies.

[3] This is based on conversations between the author and the IBM controller.

CORNERSTONE 7-6

The HOW and WHY of Using Allocated Support Department Costs to Calculate Departmental Overhead Rates

Information:

Assume that the factory in our example uses the sequential method to allocate support department costs. The cost allocation is shown in Cornerstone 7-4. The Grinding Department overhead rate is based on normal activity of 71,000 machine hours. The Assembly Department overhead rate is based on normal activity of 107,500 direct labour hours.

Job 189 required 20 machine hours in Grinding and five direct labour hours in Assembly. Total direct materials cost was $465, and total direct labour cost was $370.

Why:

One reason for support department cost allocation is to allow producing departments to calculate overhead rates. The overhead rates are then used to cost product.

Required:

1. Calculate the overhead rate for Grinding based on machine hours and the overhead rate for Assembly based on direct labour hours.
2. Using the overhead rates calculated in Requirement 1, calculate the cost of Job 189.
3. ***What if*** Job 189 had required five machine hours in Grinding and 20 direct labour hours in Assembly? Direct labour and direct materials costs remained the same. Calculate the new cost of Job 189.

Solution:

1. Grinding Department overhead rate = $355,000/71,000
   = $5 per machine hour
   Assembly Department overhead rate = $215,000/107,500
   = $2 per direct labour hour

2. Cost of Job 189:

Direct materials	$465
Direct labour cost	370
Applied overhead:	
Grinding (20 × $5)	100
Assembly (5 × $2)	10
Total cost	$945

3. New Cost of Job 189:

Direct materials	$465
Direct labour cost	370
Applied overhead:	
Grinding (5 × $5)	25
Assembly (20 × $2)	40
Total cost	$900

Many firms have developed a business by offering specialized expertise to other companies on the basis that they can provide those services on a cost-effective basis. The reasoning is that a company that is providing a single service to a variety of clients can develop expertise in that function that a company whose main focus is in another area, such as manufacturing or service provision, cannot develop itself.

So it is increasingly important that managers understand the true cost of providing such services and which parts of the organization are using the services. When considering outsourcing, companies must evaluate the qualitative as well as the quantitative factors to ensure that they are not entrusting essential activities to others in ways that might work against them in the marketplace.

Accounting for Joint Production Processes

OBJECTIVE 5

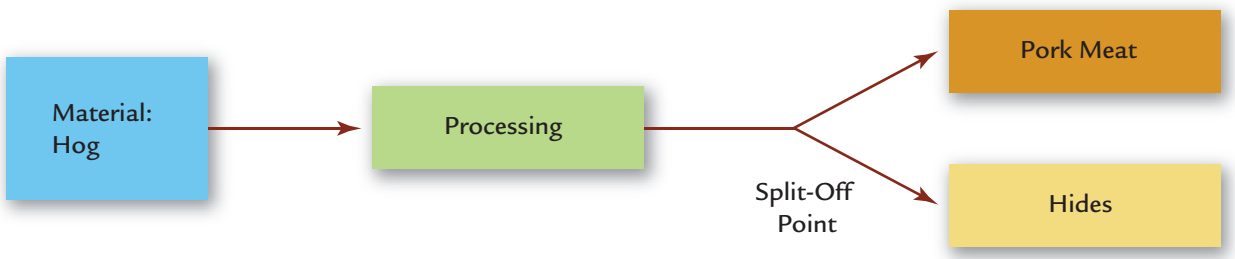
Identify the characteristics of the joint production process, and allocate joint costs to products.

Joint products are two or more products produced simultaneously by the same process up to a "split-off" point. The **split-off point** is the point at which the joint products become separate and identifiable. For example, oil and natural gas are joint products. When a company drills for oil, it gets natural gas as well. As a result, the costs of exploration, acquisition of mineral rights, and drilling are incurred to the initial split-off point. Such costs are necessary to bring crude oil and natural gas out of the ground, and they are common costs to both products. Of course, some joint products may require processing beyond the split-off point. For example, crude oil can be processed further into aviation fuel, gasoline, kerosene, naptha, and other petrochemicals. The key point, however, is that the direct materials, direct labour, and overhead costs incurred up to the initial split-off point are joint costs that can only be allocated to the final product in some arbitrary manner. Joint products are so enmeshed that once the decision to produce has been made, management decision has little effect on the output, at least to the initial split-off point. Exhibit 7-8 depicts the joint production process. Joint products are related to one another such that an increase in the output of one increases the output of the others, although not necessarily in the same ratio. Up to the split-off point, you cannot get more of one product without getting more of the other(s).

Costs are either separable or not. **Separable costs** are easily traced to individual products and offer no particular problem. If not separable, they are allocated to various products for various reasons. Cost allocations are arbitrary. That is, there is no well-accepted theoretical way to determine which product incurs what part of the joint cost. In reality, all joint products benefit from the entire joint cost. The objective in joint cost allocation is to determine the most appropriate way to allocate a cost

Exhibit 7-8

Joint Production Process



that is not really separable. The primary reason for joint cost allocation is that financial reporting (GAAP) and federal income tax law require it. In addition, these product costs are somewhat useful in calculating the cost of special lots or orders including government cost-type contracts and in justifying prices for legislative or administrative regulations. It is important to note that the allocation of joint costs is not appropriate for certain types of management decisions. The impact of joint costs on decision making is reserved for Chapter 11.

There are two important differences between costs incurred up to the split-off point in joint product situations and those indirect costs incurred for products that are produced independently. First, certain costs such as direct materials and direct labour, which are directly traceable to products when two or more products are separately produced, become indirect and indivisible when used prior to the split-off point. For example, if ore contains both iron and zinc, the direct material itself is a joint product. Since neither zinc nor iron can be produced alone prior to the split-off point, the related processing costs of mining, crushing, and splitting the ore are also joint costs. Second, manufacturing overhead becomes even more indirect in joint product situations. Consider the purchase of pineapples. A pineapple, in and of itself, is not a joint product. However, when pineapples are purchased for canning, the initial processing or trimming of the fruit results in a variety of products (skin for animal feed, trimmed core for further slicing and dicing, and juice). The processing costs to the point of split-off, as well as the cost of the original pineapples, are mutually beneficial to all products produced to that point. Both of these phenomena are caused either because the material itself is a joint product or because processing results in the simultaneous output of more than one product.

Accounting for Joint Product Costs

The accounting for overall joint costs of production (direct materials, direct labour, and overhead) is no different from the accounting for product costs in general. It is the *allocation* of joint costs to the individual products that is the source of difficulty. Still, the allocation must be done for financial reporting purposes—to value inventory carried on the balance sheet and to determine income. Thus, an allocation method must be found that, though arbitrary, allocates the costs on as reasonable a basis as possible. Because judgment is involved, equally competent accountants can arrive at different costs for the same product. There are a variety of methods for allocating joint costs. These methods include the physical units method, the weighted average method, the sales-value-at-split-off method, the net realizable value method, and the constant gross margin percentage method. These are covered in the following sections.

Physical Units Method

Under the **physical units method**, joint costs are distributed to products on the basis of some physical measure. These physical measures may be expressed in units such as kilograms, tonnes, litres, board feet, atomic weight, or heat units. If the joint products do not share the same physical measure (e.g., one product is measured in litres, another in kilograms), some common denominator may be used. For example, a producer of fuels may take litres, barrels, and tonnes and convert each one into BTUs (British thermal units) of energy.

Computationally, the physical units method allocates the same proportion of joint cost to each product as the underlying proportion of units. So, if a joint process yields 300 kilograms of Product A and 700 kilograms of Product B, Product A receives 30 percent of the joint cost and Product B receives 70 percent. Alternatively, one can divide total joint costs by total output to find an average unit cost. The average unit cost is then multiplied by the number of units of each product. Cornerstone 7-7 shows how and why the physical units method can be used to allocate joint cost.

The HOW and WHY of Using the Physical Units Method to Allocate Joint Product Costs

CORNERSTONE 7-7

Information:

A sawmill processes logs into four grades of lumber totalling 3,000,000 board feet as follows:

Grades	Board Feet
First and second	450,000
No. 1 common	1,200,000
No. 2 common	600,000
No. 3 common	750,000
Total	3,000,000

Total joint cost is $186,000.

Why:

The joint cost must be allocated to the various grades of lumber in order to cost product and value inventory. Physical units allocate the cost in proportion to the number of units and is useful when the value of one product (here, grade) is close to the value of another product.

Required:

1. Allocate the joint cost to the four grades of lumber using the physical units method.
2. Allocate the joint cost to the four grades of lumber by finding the average joint cost per board foot and multiplying it by the number of board feet in the grade.
3. ***What if*** First and second and No. 1 common each had 825,000 board feet? How would that affect the allocation of cost to these two grades? How would it affect the allocation of cost to the No. 2 and No. 3 common grades?

Solution:

1.

Grades	Board Feet (2)	Percent of Units* (3)	Joint Cost Allocation (3) × $186,000
First and second	450,000	15%	$ 27,900
No. 1 common	1,200,000	40	74,400
No. 2 common	600,000	20	37,200
No. 3 common	750,000	25	46,500
Total	3,000,000	100%	$186,000

* Percent for First and second = 450,000/3,000,000 = 0.15, or 15%
Percent for No. 1 common = 1,200,000/3,000,000 = 0.40, or 40%
Percent for No. 2 common = 600,000/3,000,000 = 0.20, or 20%
Percent for No. 3 common = 750,000/3,000,000 = 0.25, or 25%

2. Average joint cost = $186,000/3,000,000 board feet = $0.062
First and second joint cost allocation = $0.062 × 450,000 = $27,900
No. 1 common joint cost allocation = $0.062 × 1,200,000 = $74,400

CORNERSTONE 7-7 (continued)

No. 2 common joint cost allocation = $0.062 × 600,000 = $37,200
No. 3 common joint cost allocation = $0.062 × 750,000 = $46,500
(*Note:* Either method gives the same allocation results.)

3. If First and second and No. 1 common each had 825,000 board feet, then each would receive 27.5 percent (825,000/3,000,000) of the joint cost, or $51,150 (27.5% × $186,000). There would be no impact on the allocation to No. 2 common and No. 3 common since their proportion of total board feet did not change.

Although the physical units method is not wholly satisfactory, it has a measure of logic behind it. Since all products are manufactured by the same process, it is impossible to say that one costs more per unit to produce than the other. For example, manufacturers of forest products may add the average cost of logs entering the mill to the average conversion cost to arrive at an average finished product cost. This cost is applied to all finished products, no matter their type, grade, or market value. This method serves the purpose of product costing.

The physical units method may be used in any industry that processes joint products of differing grades (e.g., flour milling, tobacco, and lumber). However, a disadvantage of the physical units method is that high profits may be reflected from the sale of the high grades, with low profits or losses reflected on the sale of lower grades. This may result in incorrect managerial decisions if the data are not properly interpreted.

The physical units method presumes that each unit of material in the final product costs just as much to produce as any other. This is especially true where the dominant element can be traced to the product. Many feel this method often is unsatisfactory because it ignores the fact that not all costs are directly related to physical quantities. Also, the product might not have been produced at all if it had been physically separable before the split-off point from the part desired.

Weighted Average Method Some shortcomings encountered under the physical units method can be overcome by using weight factors. These weight factors may include such diverse elements as amount of material used, difficulty to manufacture, time consumed, difference in type of labour used, and size of unit. These factors and their relative weights are usually combined in a single value, called the **weight factor**.

An example of the use of weight factors is found in the canning industry.[4] One type of weight factor is used to convert different-size cases of peaches into a uniform size for purposes of allocating joint costs to each case. Thus, if a basic case contains 24 cans of peaches in size 2½ cans, that case is assigned a weight factor of 1.0. A case with 24 cans in size 303 (a can roughly half the size of the 2½ can) receives a weight of 0.57, and so on. Once all types of cases have been converted into basic cases using the weight factors, joint costs can be allocated according to the physical units method. Peaches can also be assigned weight factors according to grade (e.g., fancy, choice, standard, and pie). If the standard grade is weighted at 1.00, then the better grades are weighted more heavily and the pie grade less heavily. Cornerstone 7-8 shows how and why the weighted average method can be used to allocate joint costs to different products.

As Cornerstone 7-8 shows, once the weight factors are applied, the physical units can be applied to obtain the percentage of weighted cases for each grade. These

[4] The peach-canning example is adapted from K. E. Jankowski, "Cost and Sales Control in the Canning Industry," *N.A.C.A. Bulletin* 36 (November 1954): 376.

The HOW and WHY of Using the Weighted Average Method to Allocate Joint Product Costs

CORNERSTONE 7-8

Information:

A peach-canning factory purchases $5,000 of peaches; grades them into fancy, choice, standard, and pie quality; and then cans each grade. The following data on grade, number of cases, and weight factor follow:

	Number of Cases	Weight Factor
Fancy	100	1.30
Choice	120	1.10
Standard	303	1.00
Pie	70	0.50
Total	593	

Why:

The joint cost must be allocated to the various grades of peaches in order to cost the product and value inventory. The weighted average method allows firms to place relatively more value on certain types or grades of units than on others.

Required:

1. Allocate the joint cost to the four grades of peaches using the weighted average method.
2. ***What if*** the factory found that peaches for pie were being valued more by customers and decided to increase the weight factor for pie peaches to 1.00? How would that affect the allocation of cost to pie peaches? How would it affect the allocation of cost to the remaining grades?

Solution:

1.

Grades	Number of Cases	Weight Factor	Weighted Number of Cases	Percent	Allocated Joint Cost
Fancy	100	1.30	130	0.21667	$1,083
Choice	120	1.10	132	0.22000	1,100
Standard	303	1.00	303	0.50500	2,525
Pie	70	0.50	35	0.05833	292
Total			600		$5,000

2. If the pie grade weight factor is increased to 1.00, then the weighted number of cases would double and pie peaches would receive a relatively larger amount of joint cost. However, the allocation of cost to all other grades will decrease since the increased weighted cases for pie will impact all percentages. The following table shows what would happen:

Grades	Number of Cases	Weight Factor	Weighted Number of Cases	Percent	Allocated Joint Cost
Fancy	100	1.30	130	0.2047	$1,023*
Choice	120	1.10	132	0.2079	1,040
Standard	303	1.00	303	0.4772	2,386
Pie	70	1.00	70	0.1102	551
Total			635		$5,000

* rounded

percentages are then multiplied by the joint cost to yield the allocated joint cost. The effect is to allocate relatively more of the joint cost to the fancy and choice grades because they represent more desirable peaches. The pie grade peaches, the good bits and pieces from bruised peaches, are relatively less desirable and are assigned a lower weight.

Frequently, weight factors are predetermined and set up as part of either an estimated cost or a standard cost system. The use of carefully constructed weight factors enables the cost accountant to give more attention to several influences and, therefore, results in more reasonable allocations. The real danger, of course, is that weights may be used that are either inappropriate in the first place or become so through the passage of time. Obviously, if arbitrary rates are used, the resulting costs of individual products will be arbitrary.

Allocation Based on Relative Market Value

Many accountants believe that joint costs should be allocated to individual products according to their ability to absorb joint costs. The advantage of this approach is that joint cost allocation will not produce consistently profitable or unprofitable items. The rationale for using ability to bear is the assumption that costs would not be incurred unless the jointly produced products together would yield enough revenue to cover all costs plus a reasonable return. On the other hand, fluctuations in the market value of any one or more of the end products automatically change the apportionment of the joint costs, although they actually cost no more or no less to produce than before.

The relative market value approach to joint cost allocation is better than the physical units approach provided that two conditions hold: (1) the physical mix of output can be altered by incurring more (less) total joint costs and (2) this alteration produces more (less) total market value.[5] Several variants of the relative market value method are found in practice.

Allocation Based on Sales Value at Split-Off Point

The **sales-value-at-split-off method** allocates joint cost based on each product's proportionate share of market or sales value at the split-off point. Under this method, the higher the market value, the greater the share of joint cost charged against the product. As long as the prices at split-off are stable, or the fluctuations in prices of the various products are synchronized (not necessarily in amount, but in the rate of change), their respective allocated costs remain constant. Cornerstone 7-9 shows how and why to allocate joint costs using the sales-value-at-split-off method.

The sales-value-at-split-off method can be approximated through the use of weighting factors based on price. The advantage is that the price-based weights do not change as market prices do. An example of this method is found in the glue industry. Material is put into process in the Cooking Department. The products resulting from the cooking operations are the several "runs of glue." The first run is of the highest grade, has the highest market value, and costs the least. Successive runs require higher temperatures, cost more, and produce lower grades of products. Glue factories do not attempt to determine the actual cost of each skimming because the effect would be to show the lowest cost on the first grade of product and the highest cost on the lowest grade. Instead, the cost of all glue produced is determined, and this total cost is spread over the various grades on the basis of their respective tests of purity. The relative degree of purity is an indicator of the quality and, therefore, of the market value of each run or grade produced. Hence,

[5] William Cats-Baril, James F. Gatti, and D. Jacque Grinnell, "Joint Product Costing in the Semiconductor Industry," *Management Accounting* (February 1986): 29.

The HOW and WHY of Using the Sales-Value-at-Split-Off Method to Allocate Joint Product Costs

CORNERSTONE 7-9

Information:

A sawmill processes logs into four grades of lumber totalling 3,000,000 board feet as follows:

Grades	Board Feet	Price at Split-Off
First and second	450,000	$0.300
No. 1 common	1,200,000	0.200
No. 2 common	600,000	0.121
No. 3 common	750,000	0.070
Total	3,000,000	

Total joint cost is $186,000.

Why:

The joint cost must be allocated to the various grades of lumber in order to cost product and value inventory. The sales-value-at-split-off method allocates the joint cost in proportion to each product's sales value at the split-off point.

Required:

1. Allocate the joint cost to the four grades of lumber using the sales-value-at-split-off method.
2. ***What if*** First and second and No. 1 common each had 825,000 board feet? How would that affect the allocation of cost to these two grades? How would it affect the allocation of cost to the No. 2 and No. 3 common grades?

Solution:

1.

Grades	Board Feet Produced	Price at Split-Off	Sales Value at Split-Off	Percent of Total Market Value	Allocated Joint Cost
First and second	450,000	$0.300	$135,000	0.2699	$ 50,202*
No. 1 common	1,200,000	0.200	240,000	0.4799	89,261
No. 2 common	600,000	0.121	72,600	0.1452	27,007
No. 3 common	750,000	0.070	52,500	0.1050	19,530
Total	3,000,000		$500,100		$186,000

* rounded

Sales value at split-off for First and second = 450,000 × $0.300 = $135,000

Sales value at split-off for No. 1 common = 1,200,000 × $0.200 = $240,000

Sales value at split-off for No. 2 common = 600,000 × $0.121 = $72,600

Sales value at split-off for No. 3 common = 750,000 × $0.070 = $52,500

Percent for First and second = $135,000/$500,100 = 0.2699, or 26.99%

Percent for No. 1 common = $240,000/$500,100 = 0.4799, or 47.99%

Percent for No. 2 common = $72,600/$500,100 = 0.1452, or 14.52%

Percent for No. 3 common = $52,500/$500,100 = 0.1050, or 10.50%

CORNERSTONE 7-9 *(continued)*

First and second joint cost allocation = 0.2699 × $186,000 = $50,202*
No. 1 common joint cost allocation = 0.4799 × $186,000 = $89,261
No. 2 common joint cost allocation = 0.1452 × $186,000 = $27,007
No. 3 common joint cost allocation = 0.1050 × $186,000 = $19,530

2. If First and second and No. 1 common each had 825,000 board feet, then First and second would have a much higher sales value at split-off and would receive a higher percentage of joint cost. No. 1 common would have a lower sales value at split-off and receive a lower joint cost allocation. While the sales value at split-off of No. 2 common and No. 3 common would not be affected, their sales value as a percent of the total would go down since the increased value for First and second went up. Results of this change follow:

Grades	Board Feet Produced	Price at Split-Off	Sales Value at Split-Off	Percent of Total Market Value	Allocated Joint Cost
First and second	825,000	$0.300	$247,500	0.4604	$ 85,635*
No. 1 common	825,000	0.200	165,000	0.3069	57,083
No. 2 common	600,000	0.121	72,600	0.1350	25,110
No. 3 common	750,000	0.070	52,500	0.0977	18,172
Total	3,000,000		$537,600		$186,000

* rounded

multiplying the yield for each run by its relative purity is equivalent to multiplying it by the market value. The amounts weighted by purity are used to allocate the joint costs to each run. Additional runs would be undertaken, of course, only as long as the incremental revenue of the additional run is equal to or exceeds the incremental costs incurred.

The weighting factor based on market value at split-off is conceptually the same as the weighting factor method under physical units. However, in this case, the weighting factor is based on sales value, while the weighting factor described in the physical units section could be based on other considerations such as processing difficulty, size, and so on, that may or may not be related to market value.

Net Realizable Value Method When market value is used to allocate joint costs, we are talking about market value *at the split-off point*. However, on occasion, there is no ready market price for the individual products at the split-off point. In this case, the net realizable value method can be used. First, we obtain a **hypothetical sales value** for each joint product by subtracting all separable (or further) processing costs from the eventual market value. This approximates the sales value at split-off. Then, the **net realizable value method** can be used to prorate the joint costs based on each product's share of hypothetical sales value. Cornerstone 7-10 shows how and why to use the net realizable value method to allocate joint costs.

The net realizable value method is particularly useful when one or more products cannot be sold at the split-off point but must be processed further.

Constant Gross Margin Percentage Method The net realizable value method is easy to apply. However, it assigns all profit to the hypothetical market value. In other words, the further processing costs are assumed to have no profit

The HOW and WHY of Using the Net Realizable Value Method to Allocate Joint Product Costs

CORNERSTONE 7-10

Information:

A company manufactures two products, Alpha and Beta, from a joint process. Each production run costs $5,750 and results in 1,000 litres of Alpha and 3,000 litres of Beta. Neither product is salable at split-off, but must be further processed such that the separable cost for Alpha is $1 per litre and for Beta is $2 per litre. The eventual market price for Alpha is $5 and for Beta, $4.

Why:

The net realizable value method is used when one or more of the joint products cannot be sold at split-off. In this case, a hypothetical market value is constructed so that joint cost allocation can be done as close to the split-off point as possible.

Required:

1. Allocate the joint cost to Alpha and Beta using the net realizable value method.
2. ***What if*** it cost $2 to process each litre of Alpha beyond the split-off point? How would that affect the allocation of joint cost to these two products?

Solution:

1.

Product	Market Price (1)	–	Further Processing Cost (2)	=	Hypothetical Market Price (3)	×	Number of Units (4)	=	Hypothetical Market Value (5)	Percent*	Allocated Joint Cost**
Alpha	$5.00		$1.00		$4.00		1,000		$ 4,000	0.40	$2,300
Beta	4.00		2.00		2.00		3,000		6,000	0.60	3,450
Total									$10,000		$5,750

* Percent for Alpha = $4,000/$10,000 = 0.40, or 40%
Percent for Beta = $6,000/$10,000 = 0.60, or 60%
** Alpha joint cost allocation = 0.40 × $5,750 = $2,300
Beta joint cost allocation = 0.60 × $5,750 = $3,450

2. If it cost $2 to process each litre of Alpha, the hypothetical market price would be less, the hypothetical market value would be less, and Alpha would receive a smaller allocation of joint cost. The following table shows the results:

Product	Market Price (1)	–	Further Processing Cost (2)	=	Hypothetical Market Price (3)	×	Number of Units (4)	=	Hypothetical Market Value (5)	Percent*	Allocated Joint Cost**
Alpha	$5.00		$2.00		$3.00		1,000		$3,000	0.3333	$1,916
Beta	4.00		2.00		2.00		3,000		6,000	0.6667	3,834
Total									$9,000		$5,750

* Percent for Alpha = $3,000/$9,000 = 0.3333, or 33.33% (rounded)
Percent for Beta = $6,000/$9,000 = 0.6667, or 66.67% (rounded)
** Alpha joint cost allocation = 0.3333 × $5,750 = $1,916 (rounded)
Beta joint cost allocation = 0.6667 × $5,750 = $3,834 (rounded)

value even though they are critical to selling the products. The **constant gross margin percentage method** corrects for this by recognizing that costs incurred after the split-off point are part of the cost total on which profit is expected to be earned, and it allocates joint cost such that the gross margin percentage is the same for each product. Cornerstone 7-11 shows how and why to apply the constant gross margin percentage method in joint cost allocation.

Notice that the constant gross margin percentage method allocates more joint cost to Alpha than did the net realizable value method. This is due to the assumption of a relationship between cost and the cost-created value. That is, the net realizable value assumed no gross margin attributable to further processing costs, while the constant gross margin percentage method assumed not only that further processing yields profit but also that it yields an identical profit percentage across products. Which assumption is correct? There are two important questions: first, whether there is a "direct relationship" between cost and value and, second, whether the relationship is necessarily the same for all products jointly produced before and after the split-off point. The practice of product-line pricing to meet competition tends to make such assumptions invalid. Although exceptions exist, many companies do not try to maintain more-or-less equal margins between prices and full costs on their various products.

Accounting for By-Products

The distinction between joint products and **by-products** rests solely on the relative importance of their sales value. A by-product is a secondary product recovered in the course of manufacturing a primary product. It is a product whose total sales value is relatively minor in comparison with the sales value of the main product(s). This is not a sharp distinction, but rather one of degree. The first distinction is whether the operation is characterized by joint production. Then any by-products must be distinguished from main or joint products. By-products can be characterized by their relationship to the main products in the following manner:

1. By-product resulting from scrap, trimmings, and so forth, of the main products in essentially non-joint product types of undertakings (e.g., fabric trimmings from clothing pieces)
2. Scrap and other residue from essentially joint product types of processes (e.g., fat trimmed from beef carcasses)
3. A minor joint product situation (fruit skins and trimmings used as animal feed)

Relationships between joint products and by-products change, as do the classes of products within each of these classifications. When the relative importance of the individual products changes, the products need to be reclassified and the costing procedures changed. In fact, many by-products begin as waste materials, become economically significant (and thus become by-products), and grow in importance to finally become full-fledged joint products. For example, sawdust and wood chips in sawmill operations were originally waste, but over the years, they have gained value as a major component of particle board. The various methods of accounting for by-products reflect this development. Generally, accounting for by-products began as an extension of accounting for waste material. Revenue from the sale of the by-products is recorded as separate income, when the amount of income is so small that it has little impact on either overall cost or sales. As the value of by-product revenues becomes more significant, the cost of the main product is reduced by recoveries, and finally the by-products achieve near main product status and are allocated a share of the joint cost incurred prior to split-off.

Pork production offers examples of different types of by-products. Of course, the joint (main) products include pork roasts, bacon, ribs, sausage, and so on. Many different by-products are also produced during the meat-packing process.

The HOW and WHY of Using the Constant Gross Margin Percentage Method to Allocate Joint Product Costs

CORNERSTONE 7-11

Information:

A company manufactures two products, Alpha and Beta, from a joint process. Each production run costs $5,750 and results in 1,000 litres of Alpha and 3,000 litres of Beta. Neither product is salable at split-off, but must be further processed such that the separable cost for Alpha is $1 per litre and for Beta is $2 per litre. The eventual market price for Alpha is $5 and for Beta, $4.

Why:

The constant gross margin percentage method is used to avoid assuming that all profit occurs at the split-off point. It allocates joint cost to ensure that the same gross profit is applicable to all products.

Required:

1. Calculate the total revenue, total costs, and total gross profit the company will earn on the sale of Alpha and Beta.
2. Allocate the joint cost to Alpha and Beta using the constant gross margin percentage method.
3. ***What if*** it cost $2 to process each litre of Alpha beyond the split-off point? How would that affect the allocation of joint cost to these two products?

Solution:

1.

Total revenue [($5 × 1,000) + ($4 × 3,000)]		$17,000
Further processing costs [($1 × 1,000) + ($2 × 3,000)]	$7,000	
Joint processing costs	5,750	12,750
Total gross margin		$ 4,250

2. Gross margin percentage = Gross margin/Total revenue
= $4,250/$17,000 = 0.25, or 25%

	Alpha	Beta
Eventual market value	$5,000	$12,000
Less: Gross margin at 25% of market value	1,250	3,000
Cost of goods sold	3,750	9,000
Less separable costs:		
Alpha = $1 × 1,000 units	1,000	
Beta = $2 × 3,000 units		6,000
Allocated joint cost	$2,750	$ 3,000

3. An increase in the further processing cost of Alpha will reduce the gross margin percentage and will decrease the joint cost allocated to Alpha.

Total revenue [($5 × 1,000) + ($4 × 3,000)]		$17,000
Further processing costs [($2 × 1,000) + ($2 × 3,000)]	$8,000	
Joint processing costs	5,750	13,750
Total gross margin		$ 3,250

CORNERSTONE 7-11 *(continued)*

Gross margin percentage = Gross margin/Total revenue
= $3,250/$17,000
= 0.1912, or 19.12% (rounded)

	Alpha	Beta
Eventual market value	$5,000	$12,000
Less: Gross margin at 19.12% of market value	956	2,294
Cost of goods sold	4,044	9,706
Less separable costs:		
Alpha = $2 × 1,000 units	2,000	
Beta = $2 × 3,000 units		6,000
Allocated joint cost	$2,044	$ 3,706

Seaboard Foods, for example, thoroughly washes its production facility at the end of each day's shift. The waste water, which contains blood and small trimmings, sluices down drains in the floor. These lead to pipes, which channel the waste water into covered containment ponds, where anaerobic bacteria get to work breaking down the proteins and producing methane. Seaboard then recovers the methane for use in utility production for the plant. There is no accounting needed for the use of the methane. It is used solely within the plant and is not resold to outside users.

Another pork by-product is heart valves for use in transplantation. These valves are sold to heart valve manufacturers, who take up to four weeks to process the bovine or porcine valves into medical grade valves. Since no further processing occurs in the packing plant, this use can be accounted for as revenue from the sale of by-products, or as an offset against the cost of the main product(s).

Treatment of the By-Product as Other Revenue If the by-product can be sold, the company can choose to credit the sale to "Other Income" or to set up an account for "Sale of By-Product." Then, the revenue from the sale of the by-product would be credited to that account. Under this method, no cost is assigned to the by-product. All joint cost is allocated to the main products. Suppose that Edwards Company manufactures several main products and one by-product from a joint production process. One production run has the following costs:

Direct materials	$15,000
Direct labour	6,500
Applied overhead	4,550
Total joint production cost	$26,050

From each production run, Edwards obtains 1,600 kilograms of Product A, 400 kilograms of Product B, and 30 kilograms of a by-product. The by-product can be sold for $5 per kilogram. When the 30 kilograms of by-product are sold, the following journal entry will be made:

Accounts Receivable	150	
Sale of By-Product		150

Notice that under this method, no cost is assigned to the by-product and it is not carried in inventory. All joint production cost ($26,050 per batch) is allocated to the main products.

Treatment of the By-Product as a Reduction in the Cost of the Main Products An alternative method is to account for any revenue received from sale of the by-product as a reduction in the joint costs of the main products. In the Edwards example, the joint cost of $26,050 would be reduced by $150 from the sale of the by-product. Then, $25,900 would be the joint cost allocated to the main products, Product A and Product B. If Edwards used the physical units method of joint cost allocation, then the following allocations would be made:

	Units	Percent	Joint Cost Allocation
Product A	1,600	80%	$20,720
Product B	400	20	5,180
Total	2,000		$25,900

In summary, there are a number of ways to account for by-products. The treatments of by-product revenue as other income or as a deduction in the cost of the main products are the most commonly used accounting methods. By definition, by-product is immaterial. Thus, the accounting treatment focuses on methods that are relatively quick and simple.

Ethical Implications of Cost Allocation

ETHICS This chapter has dealt with the subject of cost allocation, that is, moving cost from one department or product to another department or product. There are good reasons for reallocating costs and many widely accepted and used ways of doing this. However, the ability to allocate costs among various cost objects gives management a fair amount of discretion as to how the allocation is done. We have seen that some ways of allocating costs assign relatively more costs to a particular support department or joint product than other ways of allocating costs. The question arises, is this cost allocation ethical? As always, we return to the fundamentals of business. The business is ethical if it treats all parties fairly and does not attempt to mislead or misstate results.

If managers are not careful in the method they choose to allocate costs, one department may be unduly penalized while another may get an advantage. The issue then becomes one of favouring one department (and its managers) over another. Ethically, this is wrong.◆

Summary of Learning Objectives

1. Describe the difference between support departments and producing departments.

- Producing departments create the products or services that the firm is in business to make and sell.
- Support departments serve producing departments but do not create a salable product.
- The costs of the support departments must be allocated to producing departments for:
  - Inventory valuation
  - Product-line profitability
  - Pricing
  - Planning and control. Allocation can also be used to encourage favourable managerial behaviour.

2. Calculate charging rates, and distinguish between single and dual charging rates.

- Single charging rate combines variable and fixed costs of the support department.
  - Budgeted fixed and variable costs are in the numerator and budgeted usage is in the denominator.
  - Actual usage by using departments is multiplied by the charging rate to get the amount charged.

- Dual rates separate the fixed and variable costs.
  - Fixed support department costs are allocated on the basis of original capacity demands.
  - Variable rate is based on budgeted usage.
- Budgeted costs, not actual costs, should be allocated.
  - Efficiencies or inefficiencies of the support departments are not passed on to the producing departments.
  - Because the causal factors can differ for fixed and variable costs, these types of costs should be allocated separately.

3. Allocate support centre costs to producing departments using the direct method, the sequential method, and the reciprocal method.

- All three methods allocate all support department costs to the producing departments.
- The three methods differ in the degree of support department interaction considered.
  - The direct method allocates from support to producing departments. No reciprocity is recognized.
  - The sequential (or step) method ranks support departments and allocates from top ranking to lower ranking. Some reciprocity is recognized.
  - The reciprocal method takes full account of support department reciprocity.
- After allocation, zero cost remains in the support departments.
- Pre-allocation total overhead must equal post-allocation overhead.

4. Calculate departmental overhead rates.

- After allocation, total overhead in the producing department is divided by budgeted base to obtain the departmental overhead rate.
- The departmental overhead is applied to products passing through the department.

5. Identify the characteristics of the joint production process, and allocate joint costs to products.

- Joint production processes result in the output of two or more products that are produced simultaneously.
- Joint or main products have relatively significant sales value.
- Joint costs must be allocated to the individual products for purposes of financial reporting.
- Several methods have been developed to allocate joint costs.
  - Physical units method
  - Weighted average method
  - Sales-value-at-split-off method
  - Net realizable value method
  - Constant gross margin method
- Allocated joint costs are not useful for output and pricing decisions. Further processing costs, or separable costs, are used in management decision making.
- By-products are products obtained from joint production processes that have relatively little sales value. Two methods of accounting for by-product sales are:
  - Credit of by-product revenue to "Other Income" or "Revenue from Sale of By-Product"
  - Reduction of the joint costs allocated to the main products by the amount of by-product revenue

CORNERSTONES FOR CHAPTER 7

Review Problems

I. Allocation: Direct, Sequential, and Reciprocal Methods

Digby Manufacturing produces machine parts on a job-order basis. Most business is obtained through bidding. Most firms competing with Digby bid full cost plus a 20 percent markup. Recently, with the expectation of gaining more sales, Digby reduced its markup from 25 percent to 20 percent. The company operates two service departments and two producing departments. The budgeted costs and the normal activity levels for each department are as follows:

	Service Departments		Producing Departments	
	A	B	C	D
Overhead costs	$100,000	$200,000	$100,000	$50,000
Number of employees	8	7	30	30
Maintenance hours	2,000	200	6,400	1,600
Machine hours	—	—	10,000	1,000
Labour hours	—	—	1,000	10,000

The direct costs of Department A are allocated on the basis of employees; those of Department B are allocated on the basis of maintenance hours. Departmental overhead rates are used to assign costs to products. Department C uses machine hours, and Department D uses labour hours.

The firm is preparing to bid on a job (Job K) that requires three machine hours per unit produced in Department C and no time in Department D. The expected prime costs per unit are $67.

Required:

1. Allocate the service costs to the producing departments using the direct method.
2. What will the bid be for Job K if the direct method of allocation is used?
3. Allocate the service costs to the producing departments using the sequential method.
4. What will the bid be for Job K if the sequential method is used?
5. Allocate the service costs to the producing departments using the reciprocal method.
6. What will the bid be for Job K if the reciprocal method is used?

Solution:

1.

	Service Departments		Producing Departments	
	A	B	C	D
Direct costs	$ 100,000	$ 200,000	$100,000	$ 50,000
Department A[a]	(100,000)	—	50,000	50,000
Department B[b]	—	(200,000)	160,000	40,000
Total	$ 0	$ 0	$310,000	$140,000

[a] Department A costs are allocated on the basis of the number of employees in the producing departments, Departments C and D. The percentage of Department A cost allocated to Department C = 30/(30 + 30) = 0.50. Cost of Department A allocated to Department C = 0.50 × $100,000 = $50,000. The percentage of Department A cost allocated to Department D = 30/(30 + 30) = 0.50. Cost of Department A allocated to Department D = 0.50 × $100,000 = $50,000.

[b] Department B costs are allocated on the basis of maintenance hours used in the producing departments, Departments C and D. The percentage of Department B cost allocated to Department C = 6,400/(6,400 + 1,600) = 0.80. Cost of Department B allocated to Department C = 0.80 × $200,000 = $160,000. The percentage of Department B cost allocated to Department D = 1,600/(6,400 + 1,600) = 0.20. Cost of Department B allocated to Department D = 0.20 × $200,000 = $40,000.

2. Department C: Overhead rate = $310,000/10,000 = $31 per machine hour. Product cost and bid price:

Prime cost	$ 67
Overhead (3 × $31)	93
Total unit cost	$160
Bid price ($160 × 1.2)	$192

3.

	Service Departments		Producing Departments	
	A	B	C	D
Direct costs	$ 100,000	$ 200,000	$100,000	$ 50,000
Department B[a]	40,000	(200,000)	128,000	32,000
Department A[b]	(140,000)	—	70,000	70,000
Total	$ 0	$ 0	$298,000	$152,000

[a] Department B is ranked first because its direct costs are higher than those of Department A. Department B costs are allocated on the basis of maintenance hours used in the lower ranking support department, Department A, and the producing departments, Departments C and D. The percentage of Department B cost allocated to Department A = 2,000/(2,000 + 6,400 + 1,600) = 0.20. Cost of Department B allocated to Department A = 0.20 × $200,000 = $40,000. The percentage of Department B cost allocated to Department C = 6,400/(2,000 + 6,400 + 1,600) = 0.64. Cost of Department B allocated to Department C = 0.64 × $200,000 = $128,000. The percentage of Department B cost allocated to Department D = 1,600/(2,000 + 6,400 + 1,600) = 0.16. Cost of Department B allocated to Department D = 0.16 × $200,000 = $32,000.

[b] Department A costs are allocated on the basis of number of employees in the producing departments, Departments C and D. The percentage of Department A cost allocated to Department C = 30/(30 + 30) = 0.50. Cost of Department A allocated to Department C = 0.50 × $140,000 = $70,000. The percentage of Department A cost allocated to Department D = 30/(30 + 30) = 0.50. Cost of Department A allocated to Department D = 0.50 × $140,000 = $70,000. (*Note:* Department A cost is no longer $100,000. It is $140,000 due to the $40,000 that was allocated from Department B.)

4. Department C: Overhead rate \$298,000/10,000 = \$29.80 per machine hour. Product cost and bid price:

Prime cost	\$ 67.00
Overhead (3 × \$29.80)	89.40
Total unit cost	\$156.40
Bid price (\$156.40 × 1.2)	\$187.68

5. Allocation ratios:

	Proportion of Output Used by			
	A	B	C	D
A	—	0.1045	0.44775	0.44775
B	0.2000	—	0.6400	0.1600

$$A = \$100{,}000 + 0.2000B$$
$$B = \$200{,}000 + 0.1045A$$
$$A = \$100{,}000 + 0.2(\$200{,}000 + 0.1045A)$$
$$A = \$100{,}000 + \$40{,}000 + 0.0209A$$
$$0.9791A = \$140{,}000$$
$$A = \$142{,}988$$
$$B = \$200{,}000 + 0.1045(\$142{,}988)$$
$$B = \$214{,}942$$

	Service Departments		Producing Departments	
	A	B	C	D
Direct costs	\$ 100,000	\$ 200,000	\$100,000	\$ 50,000
Department B	42,988	(214,942)	137,563	34,391
Department A	(142,988)	14,942	64,023	64,023
Total	\$ 0	\$ 0	\$301,586	\$148,414

6. Department C: Overhead rate \$301,586/10,000 = \$30.16 per machine hour. Product cost and bid price:

Prime cost	\$ 67.00
Overhead (3 × \$30.16)	90.48
Total unit cost	\$157.48
Bid price (\$157.48 × 1.2)	\$188.98

II. Joint Cost Allocation, Further Processing

Bellefleur Pharmaceutical Company purchases a material that is then processed to yield three chemicals: anarol, estyl, and betryl. In June, Bellefleur purchased 10,000 litres of the material at a cost of \$250,000, and the company incurred joint conversion costs of \$70,000. June sales and production information are as follows:

	Litres Produced	Price at Split-Off	Further Processing Cost per Litre	Eventual Sales Price
Anarol	2,000	\$55	—	—
Estyl	3,000	40	—	—
Betryl	5,000	30	\$5	\$60

Anarol and estyl are sold to other pharmaceutical companies at the split-off point. Betryl can be sold at the split-off point or processed further and packaged for sale as an asthma medication.

Required:

1. Allocate the joint costs to the three products using the physical units method, the sales-value-at-split-off method, the net realizable value method, and the constant gross margin percentage method.
2. Suppose that half of June's production of estyl could be purified and mixed with all of the anarol to produce a veterinary grade anesthetic. All further processing costs amount to $35,000. The selling price for the veterinary grade anarol is $112 per litre. Should Bellefleur further process the estyl into the anarol anesthetic?

Solution:

1. Total joint cost to be allocated: $250,000 + $70,000 = $320,000

Physical Units Method:

	Litres Produced	Percent of Litres Produced	×	Joint Cost	=	Joint Cost Allocation
Anarol	2,000	(2,000/10,000) = 0.20		$320,000		$ 64,000
Estyl	3,000	(3,000/10,000) = 0.30		320,000		96,000
Betryl	5,000	(5,000/10,000) = 0.50		320,000		160,000
Total	10,000					$320,000

Sales-Value-at-Split-Off Method:

	Litres Produced	×	Price at Split-Off	=	Revenue at Split-Off	Percent of Revenue	×	Joint Cost	=	Joint Cost Allocation
Anarol	2,000		$55		$110,000	0.28947		$320,000		$ 92,630
Estyl	3,000		40		120,000	0.31579		320,000		101,053
Betryl	5,000		30		150,000	0.39474		320,000		126,317
Total					$380,000					$320,000

Net Realizable Value Method:

Step 1: Determine hypothetical sales revenue.

	Eventual Price	–	Further Processing Cost per Litre	=	Hypothetical Sales Price	×	Litres	=	Hypothetical Revenue
Anarol	$55		—		$55		2,000		$110,000
Estyl	40		—		40		3,000		120,000
Betryl	60		$5		55		5,000		275,000
Total									$505,000

Step 2: Allocate joint cost as a proportion of hypothetical sales revenue.

	Hypothetical Sales Revenue	Percent	×	Joint Cost	=	Joint Cost Allocation
Anarol	$110,000	0.21782		$320,000		$ 69,702
Estyl	120,000	0.23762		320,000		76,039*
Betryl	275,000	0.54456*		320,000		174,259
Total margin	$505,000					$320,000

* Rounded.

Constant Gross Margin Percentage Method:

	Dollars	Percent
Revenue		
[($55 × 2,000) + ($40 × 3,000) + ($60 × 5,000)]	$530,000	100.00%
Costs [$320,000 + ($5 × 5,000)]	345,000	65.09
Gross margin	$185,000	34.91%

	Anarol	Estyl	Betryl
Eventual market value	$110,000	$120,000	$300,000
Less: Gross margin at 34.91%	38,401	41,892	104,730
Cost of goods sold	71,599	78,108	195,270
Less: Separable costs	—	—	(25,000)
Joint cost allocation	$ 71,599	$ 78,108	$170,270

Note: $71,599 + $78,108 + $170,270 = $319,977; there is a rounding error of $23.

2. Joint costs are irrelevant to this decision. Instead, further processing costs and the opportunity cost of lost contribution margin on the estyl diverted to anarol purification must be considered.

Added revenue ($112 − $55)(2,000)	$114,000
Less: Further processing of anarol mixture	(35,000)
Lost contribution margin on estyl (1,500 × $40)	(60,000)
Increased operating income	$ 19,000

Key Terms

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Discussion Questions

1. Describe the two-stage allocation process for assigning support service costs to products in a traditional manufacturing environment.
2. Why must support service costs be assigned to products for purposes of inventory valuation?
3. Explain how allocation of support service costs is useful for planning and control and in making pricing decisions.
4. Assume that a company has decided not to allocate any support service costs to producing departments. Describe the likely behaviour of the managers of the producing departments. Would this be good or bad? Explain why allocation would correct this type of behaviour.
5. Explain how allocating support service costs will encourage service departments to operate more efficiently.
6. Why is it important to identify and use causal factors to allocate support service costs?
7. Explain why it is better to allocate budgeted support service costs rather than actual support service costs.
8. Why is it desirable to allocate variable costs and fixed costs separately?

9. Explain why either normal or peak capacity of the producing (or user) departments should be used to allocate the fixed costs of support departments.
10. Explain why variable bases should not be used to allocate fixed costs.
11. Why is the dual-rate charging method better than the single-rate method? In what circumstances would it not matter whether dual or single rates were used?
12. Explain the difference between the direct method and the sequential method.
13. The reciprocal method of allocation is more accurate than either the direct or sequential methods. Do you agree or disagree? Explain.
14. What is a joint cost? How does it relate to by-products?
15. How do joint costs differ from other common costs?

Cornerstone Exercises

OBJECTIVE 2
CORNERSTONE 7-1

Cornerstone Exercise 7-1 CALCULATING AND USING A SINGLE CHARGING RATE

The expected costs for the Maintenance Department of Kootenay Manufacturing Inc. for the coming year include:

Fixed costs (salaries, tools): $57,200 per year
Variable costs (supplies): $0.75 per maintenance hour

Estimated usage by:

Assembly Department	4,500
Fabricating Department	6,700
Packaging Department	10,800
Total maintenance hours	22,000

Actual usage by:

Assembly Department	3,960
Fabricating Department	6,800
Packaging Department	10,000
Total maintenance hours	20,760

Required:

1. Calculate a single charging rate for the Maintenance Department.
2. Use this rate to assign the costs of the Maintenance Department to the user departments based on actual usage. Calculate the total amount charged for maintenance for the year.
3. ***What if*** the Assembly Department used 4,000 maintenance hours in the year? How much would have been charged out to the three departments?

OBJECTIVE 2
CORNERSTONE 7-2

Cornerstone Exercise 7-2 CALCULATING AND USING DUAL CHARGING RATES

The expected costs for the Maintenance Department of Kootenay Manufacturing Inc. for the coming year include:

Fixed costs (salaries, tools): $57,200 per year
Variable costs (supplies): $0.75 per maintenance hour

The Assembly and Packaging departments expect to use maintenance hours relatively evenly throughout the year. The Fabricating Department typically uses more maintenance hours in the month of November. Estimated usage in hours for the year and for the peak month are as follows:

	Yearly Hours	Monthly Peak Hours
Assembly Department	4,500	390
Fabricating Department	6,700	1,300
Packaging Department	10,800	910
Total maintenance hours	22,000	2,600

Actual usage for the year by:

Assembly Department	3,960
Fabricating Department	6,800
Packaging Department	10,000
Total maintenance hours	20,760

Required:

1. Calculate a variable rate for the Maintenance Department. Calculate the allocated fixed cost for each using department based on its budgeted peak month usage in maintenance hours.
2. Use the two rates to assign the costs of the Maintenance Department to the user departments based on actual usage. Calculate the total amount charged for maintenance for the year.
3. ***What if*** the Assembly Department used 4,000 maintenance hours in the year? How much would have been charged out to the three departments?

OBJECTIVE 3
CORNERSTONE 7-3

Cornerstone Exercise 7-3 DIRECT METHOD OF SUPPORT DEPARTMENT COST ALLOCATION

Brandon Company has two support departments, Human Resources and General Factory, and two producing departments, Fabricating and Assembly.

	Support Departments		Producing Departments	
	Human Resources	General Factory	Fabricating	Assembly
Direct costs	$150,000	$360,000	$125,000	$80,000
Normal activity:				
Number of employees	—	60	45	80
Square metres	1,500	—	6,000	14,000

The costs of the Human Resources Department are allocated on the basis of number of employees, and the costs of General Factory are allocated on the basis of square metres. Brandon Company uses the direct method of support department cost allocation.

Required:

1. Calculate the allocation ratios for the four departments using the direct method.
2. Using the direct method, allocate the costs of the Human Resources and General Factory departments to the Fabricating and Assembly departments.
3. ***What if*** the General Factory Department had 40 employees? How would that affect the allocation of Human Resources Department costs to the Fabricating and Assembly departments?

OBJECTIVE 3
CORNERSTONE 7-4

Cornerstone Exercise 7-4 SEQUENTIAL (STEP) METHOD OF SUPPORT DEPARTMENT COST ALLOCATION

Refer to **Cornerstone Exercise 7-3**. Now assume that Brandon Company uses the sequential method to allocate support department costs. The support departments are ranked in order of highest cost to lowest cost.

Required:

1. Calculate the allocation ratios (rounded to four significant digits) for the four departments using the sequential method.

2. Using the sequential method, allocate the costs of the Human Resources and General Factory departments to the Fabricating and Assembly departments. (Round all allocated costs to the nearest dollar.)
3. ***What if*** the allocation ratios in Requirement 1 were rounded to six significant digits rather than four? How would that affect any rounding error in the allocation of costs?

OBJECTIVE 3
CORNERSTONE 7-5

Cornerstone Exercise 7-5 RECIPROCAL METHOD OF SUPPORT DEPARTMENT COST ALLOCATION

Refer to **Cornerstone Exercise 7-3**. Now assume that Brandon Company uses the reciprocal method to allocate support department costs.

Required:

1. Calculate the allocation ratios (rounded to four significant digits) for the four departments using the reciprocal method.
2. Develop a simultaneous equations system of total costs for the support departments. Solve for the total reciprocated costs of each support department. (Round reciprocated total costs to the nearest dollar.)
3. Using the reciprocal method, allocate the costs of the Human Resources and General Factory departments to the Fabricating and Assembly departments. (Round all allocated costs to the nearest dollar.)
4. ***What if*** the allocation ratios in Requirement 1 were rounded to six significant digits rather than four? How would that affect any rounding error in the allocation of costs?

OBJECTIVE 4
CORNERSTONE 7-6

Cornerstone Exercise 7-6 CALCULATING DEPARTMENTAL OVERHEAD RATES USING POST-ALLOCATION COSTS

Refer to **Cornerstone Exercise 7-3** and solve for the allocated costs to Fabricating and Assembly using the direct method of support department cost allocation. The Fabricating Department overhead rate is based on normal activity of 82,000 machine hours. The Assembly Department overhead rate is based on normal activity of 160,000 direct labour hours.

Job 316 required six machine hours in Fabricating and four direct labour hours in Assembly. Total direct materials cost $175, and total direct labour cost was $200.

Required:

1. Calculate the overhead rate for Fabricating based on machine hours and the overhead rate for Assembly based on direct labour hours. (Round overhead rates to the nearest cent.)
2. Using the overhead rates calculated in Requirement 1, calculate the cost of Job 316.
3. ***What if*** Job 316 had required one machine hour in Fabricating and four direct labour hours in Assembly? Direct labour and direct materials costs remained the same. Calculate the new cost of Job 316.

OBJECTIVE 5
CORNERSTONE 7-7

Cornerstone Exercise 7-7 ALLOCATING JOINT COSTS USING THE PHYSICAL UNITS METHOD

Appletime Inc. purchases apples from local orchards and sorts them into four categories. Grade A are large blemish-free apples that can be sold to gourmet fruit sellers. Grade B apples are smaller and may be slightly out of proportion. These are packed in boxes and sold to grocery stores. Apples for slices are even smaller than Grade B apples and have blemishes. Apples for applesauce are of lower grade than apples for slices, yet still suitable for canning. Information on a recent purchase of 20,000 kilograms of apples is as follows:

Grades	Kilograms
Grade A	1,500
Grade B	5,000
Slices	8,000
Applesauce	5,500
Total	20,000

Total joint cost is $6,000.

Required:

1. Allocate the joint cost to the four grades of apples using the physical units method. (Carry out the percent calculations to four significant digits.)
2. Allocate the joint cost to the four grades of apples by finding the average joint cost per kilogram and multiplying it by the number of kilograms in the grade. (Round all cost allocations to the nearest dollar.)
3. ***What if*** there were 2,000 kilograms of Grade A apples and 4,500 kilograms of Grade B? How would that affect the allocation of cost to these two grades? How would it affect the allocation of cost to the remaining common grades?

OBJECTIVE 5
CORNERSTONE 7-8

Cornerstone Exercise 7-8 ALLOCATING JOINT COSTS USING THE WEIGHTED AVERAGE METHOD

Refer to **Cornerstone Exercise** 7-7. Assume that Appletime Inc. uses the weighted average method of joint cost allocation and has assigned the following weights to the four grades of apples:

Grades	Kilograms	Weight Factor
Grade A	1,500	3.0
Grade B	5,000	2.0
Slices	8,000	0.5
Applesauce	5,500	1.0
Total	20,000	

Total joint cost is $6,000.

Required:

1. Allocate the joint cost to the four grades of apples using the weighted average method. (Carry out the percent calculations to four significant digits. Round all cost allocations to the nearest dollar.)
2. ***What if*** the factory found that Grade A apples were being valued less by customers and decided to decrease the weight factor for Grade A apples to 2.0? How would that affect the allocation of cost to Grade A apples? How would it affect the allocation of cost to the remaining grades?

OBJECTIVE 5
CORNERSTONE 7-9

Cornerstone Exercise 7-9 ALLOCATING JOINT COSTS USING THE SALES-VALUE-AT-SPLIT-OFF METHOD

Refer to **Cornerstone Exercise** 7-7**.** Assume that Appletime Inc. uses the sales-value-at-split-off method of joint cost allocation and has provided the following information about the four grades of apples:

Grades	Kilograms	Price at Split-Off (per kg)
Grade A	1,500	$4.00
Grade B	5,000	1.00
Slices	8,000	0.50
Applesauce	5,500	0.10
Total	20,000	

Total joint cost is $6,000.

Required:

1. Allocate the joint cost to the four grades of apples using the sales-value-at-split-off method. (Carry out the percent calculations to four significant digits. Round all cost allocations to the nearest dollar.)
2. ***What if*** the price at split-off of Grade B apples increased to $1.20 per kilogram? How would that affect the allocation of cost to Grade B apples? How would it affect the allocation of cost to the remaining grades?

OBJECTIVE 5
CORNERSTONE 7-10

Cornerstone Exercise 7-10 ALLOCATING JOINT COSTS USING THE NET REALIZABLE VALUE METHOD

A company manufactures three products, L-Ten, Triol, and Pioze, from a joint process. Each production run costs $12,900. None of the products can be sold at split-off, but must be processed further. Information on one batch of the three products is as follows:

Product	Litres	Further Processing Cost per Litre	Eventual Market Price per Litre
L-Ten	3,500	$0.50	$2.00
Triol	4,000	1.00	5.00
Pioze	2,500	1.50	6.00

Required:

1. Allocate the joint cost to L-Ten, Triol, and Pioze using the net realizable value method. (Round the percentages to four significant digits. Round all cost allocations to the nearest dollar.)
2. ***What if*** it cost $2 to process each litre of Triol beyond the split-off point? How would that affect the allocation of joint cost to these three products?

OBJECTIVE 5
CORNERSTONE 7-11

Cornerstone Exercise 7-11 ALLOCATING JOINT COSTS USING THE CONSTANT GROSS MARGIN METHOD

Refer to **Cornerstone Exercise 7-10.**

Required:

1. Calculate the total revenue, total costs, and total gross profit the company will earn on the sale of L-Ten, Triol, and Pioze.
2. Allocate the joint cost to L-Ten, Triol, and Pioze using the constant gross margin percentage method.
3. ***What if*** it cost $2 to process each litre of Triol beyond the split-off point? How would that affect the allocation of joint cost to these three products?

Exercises

OBJECTIVE 1

Exercise 7-12 CLASSIFYING DEPARTMENTS AS PRODUCING OR SUPPORT—MANUFACTURING FIRM

Classify each of the following departments in a factory that produces crème-filled snack cakes as a producing department or a support department.

a. Janitorial
b. Baking
c. Inspection
d. Mixing
e. Engineering
f. Grounds
g. Purchasing
h. Packaging
i. Icing (frosts top of snack cakes and adds decorative squiggle)
j. Filling (injects crème mixture into baked snack cakes)
k. Personnel
l. Cafeteria
m. General factory
n. Machine maintenance
o. Bookkeeping

OBJECTIVE 1
SERVICE

Exercise 7-13 CLASSIFYING DEPARTMENTS AS PRODUCING OR SUPPORT—SERVICE FIRM

Classify each of the following departments in a large metropolitan law firm as a producing department or a support department.

a. Copying
b. WESTLAW computer research
c. Tax planning
d. Environmental law
e. Oil and gas law
f. Custodians
g. Word processing
h. Corporate law
i. Small business law
j. Personnel

Exercise 7-14 IDENTIFYING CAUSAL FACTORS FOR SUPPORT DEPARTMENT COST ALLOCATION

OBJECTIVE 1

Identify some possible causal factors for the following support departments:

a. Cafeteria
b. Custodial services
c. Laundry
d. Receiving, shipping, and stores
e. Maintenance
f. Personnel
g. Accounting
h. Power
i. Building and grounds

Exercise 7-15 OBJECTIVES OF COST ALLOCATION

OBJECTIVE 1

SERVICE

Dr. Fred Poston, "Dermatologist to the Stars," has a practice in southern California. The practice includes three dermatologists, three medical assistants, an office manager, and a receptionist. The office space, which is rented for $5,000 per month, is large enough to accommodate four dermatologists, but Dr. Poston has not yet found the right physician to fill the fourth spot. Dr. Poston developed a skin cleanser for his patients that is nongreasy and does not irritate skin that is still recovering from the effects of chemical peels and dermabrasion. The cleanser requires $0.50 worth of ingredients per 200-gram bottle. A medical assistant mixes up several bottles at a time during lulls in her schedule. She waits until she has about 15 minutes free and then mixes 10 bottles of cleanser. She is paid $2,250 per month. Dr. Poston charges $5.00 per bottle and sells approximately 5,000 bottles annually. His accountant is considering various ways of costing the skin cleanser.

Required:

1. Give two reasons for allocating overhead cost to the cleanser. How should the cost of the office space and the medical assistant's salary be allocated to the cleanser? Explain.
2. Suppose that *Healthy You* magazine runs an article on Dr. Poston and his skin cleanser, which causes demand to skyrocket. Consumers across the country buy the cleanser via phone or mail order. Now, Dr. Poston believes that he can sell about 40,000 bottles annually. He can hire someone part time, for $1,000 per month, to mix and bottle the cleanser and to handle the financial business of the cleanser. An unused office and examining room can be dedicated to the production of the cleanser. Would your allocation choice for Requirement 1 change in this case? Explain.

Exercise 7-16 OBJECTIVES OF ALLOCATION

OBJECTIVE 1

SERVICE

Hallie and Ashley are planning a trip to Tofino, B.C., during spring break. Members of the varsity volleyball team, they are looking forward to five days of beach volleyball and parasailing. They will drive Hallie's car and estimate that they will pay the following costs during the trip:

Motel	$625
Food (each)	150
Gas in total	120
Parasailing and equipment rental (each)	125

They have reservations at the Beach-Vue Motel, which charges $95 per night for a single, $125 per night for a double, and an additional $20 per night if a rollaway bed is added to a double room.

Hallie's little sister, Courtney, wants to go along. She isn't into sports but thinks that five days of partying and relaxing on the beach would be a great way to unwind from the rigours of school. She figures that she could ride with Hallie and Ashley and share their room.

Required:

1. Using incremental costs only, what would it cost Courtney to accompany Hallie and Ashley?
2. Using the benefits-received method, what would it cost Courtney to go on the trip?

OBJECTIVE 2

Exercise 7-17 SINGLE AND DUAL CHARGING RATES

SERVICE

Jeff Park owns a small neighbourhood shopping mall. Of the 10 store spaces in the building, seven are rented by boutique owners and three are vacant. Jeff has decided that offering more services to stores in the mall would enable him to increase occupancy. He has decided to use one of the vacant spaces to provide, at cost, a gift-wrapping service to shops in the mall. The boutiques are enthusiastic about the new service. Most of them are staffed minimally, which means that every time they have to wrap a gift, phones go unanswered and other customers in line grow impatient. Jeff figured that the gift-wrapping service would incur the following costs: The store space would normally rent for $1,800 per month; part-time gift wrappers could be hired for $1,500 per month; and wrapping paper and ribbon would average $1.20 per gift. The boutique owners estimated the following number of gifts to be wrapped per month.

Store	Number of Gifts Wrapped per Month
The Stationery Station	175
Arts & Collectibles	400
Kid-Sports	100
Java Jim's	75
Designer Shoes	20
Cristina's Closet	130
Alan's Drug and Sundries	100

After the service had been in effect for six months, Jeff calculated the following actual average monthly number of gifts wrapped for each of the stores.

Store	Actual Average Number of Gifts Wrapped per Month
The Stationery Station	160
Arts & Collectibles	420
Kid-Sports	240
Java Jim's	10
Designer Shoes	50
Cristina's Closet	200
Alan's Drug and Sundries	450

Required:

1. Calculate a single charging rate, on a per-gift basis, to be charged to the shops. Based on the shops' actual number of gifts wrapped, how much would be charged to each shop using the single charging rate?
2. Based on the shops' actual number of gifts wrapped, how much would be charged to each shop using the dual charging rate?
3. Which shops would prefer the single charging rate? Why? Which would prefer the dual charging rate, and why?
4. Several of the shop owners were angry about their bill for the gift-wrapping service. They pointed out that they were to be charged only for the cost of the service. How could you make a case for them?

OBJECTIVE 2

Exercise 7-18 ACTUAL VERSUS BUDGETED COSTS

Kumar Inc. evaluates managers of producing departments on their ability to control costs. In addition to the costs directly traceable to their departments, each production manager is held responsible for a share of the costs of a support centre, the Human Resources (HR) Department. The total costs of HR are allocated on the basis of actual

direct labour hours used. The total costs of HR and the actual direct labour hours worked by each producing department are as follows:

	Year 1	Year 2
Direct labour hours worked:		
Department A	24,000	25,000
Department B	36,000	25,000
Total hours	60,000	50,000
Actual HR cost	$120,000	$120,000
Budgeted HR cost	115,000*	112,500*

* $0.25 per direct labour hour plus $100,000.

Required:

1. Allocate the HR costs to each producing department for Year 1 and Year 2 using the direct method with actual direct labour hours and actual HR costs.
2. Discuss the following statement: "The costs of human resource-related matters increased by 25 percent for Department A and decreased by over 16 percent for Department B. Thus, the manager of Department B must be controlling HR costs better than the manager of Department A."
3. Can you think of a way to allocate HR costs so that a more reasonable and fair assessment of cost control can be made? Explain.

Exercise 7-19 FIXED AND VARIABLE COST ALLOCATION

OBJECTIVE 2

Refer to the data in **Exercise 7-18**. When the capacity of the HR Department was originally established, the normal usage expected for each department was 20,000 direct labour hours. This usage is also the amount of activity planned for the two departments in Year 1 and Year 2.

Required:

1. Allocate the costs of the HR Department using the direct method and assuming that the purpose is product costing.
2. Allocate the costs of the HR Department using the direct method and assuming that the purpose is to evaluate performance.

Exercise 7-20 DIRECT METHOD AND OVERHEAD RATES

OBJECTIVE 3

Ormond Company manufactures both toothpaste and tooth whitener, with each product manufactured in separate departments. Three support departments support the production departments: Power, General Factory, and Purchasing. Budgeted data on the five departments are as follows:

	Support Departments			Producing Departments	
	Power	General Factory	Purchasing	Toothpaste	Tooth Whitener
Overhead	$90,000	$420,000	$180,000	$141,600	$175,000
Square metres	3,000	—	3,000	9,600	8,400
Machine hours	—	1,403	1,345	8,000	24,000
Purchase orders	20	40	7	60	120

The company does not break overhead into fixed and variable components. The bases for allocation are: power—machine hours, general factory—square metres, and purchasing—purchase orders.

Required:

1. Allocate the overhead costs to the producing departments using the direct method. (Take allocation ratios out to four significant digits.)
2. Using machine hours, compute departmental overhead rates. (Round the overhead rates to the nearest cent.)

OBJECTIVE 3

Exercise 7-21 SEQUENTIAL METHOD

Refer to the data in **Exercise 7-20**. The company has decided to use the sequential method of allocation instead of the direct method. The support departments are ranked in order of highest cost to lowest cost.

Required:

1. Allocate the overhead costs to the producing departments using the sequential method. (Take allocation ratios out to four significant digits.)
2. Using machine hours, compute departmental overhead rates. (Round the overhead rates to the nearest cent.)

OBJECTIVE 3

Exercise 7-22 RECIPROCAL METHOD

Waxman Company has two producing departments and two support departments. The following budgeted data pertain to these four departments:

	Support Departments		Producing Departments	
	General Factory	Receiving	Assembly	Finishing
Direct overhead	$400,000	$160,000	$43,000	$74,000
Square metres	—	2,700	5,400	5,400
Number of receiving orders	300	—	1,680	1,020
Direct labour hours	—	—	25,000	40,000

Required:

1. Allocate the overhead costs of the support departments to the producing departments using the reciprocal method. (Round allocation ratios to four significant digits. Round allocated costs to the nearest dollar.)
2. Using direct labour hours, compute departmental overhead rates. (Round allocation ratios to four significant digits. Round allocated costs to the nearest dollar.)

OBJECTIVE 3

Exercise 7-23 DIRECT METHOD

Refer to the data in **Exercise 7-22**. The company has decided to simplify its method of allocating support service costs by switching to the direct method.

Required:

1. Allocate the costs of the support departments to the producing departments using the direct method. (Round allocation ratios to four significant digits. Round allocated costs to the nearest dollar.)
2. Using direct labour hours, compute departmental overhead rates. (Round to the nearest cent.)

OBJECTIVE 3

Exercise 7-24 SEQUENTIAL METHOD

Refer to the data in **Exercise 7-22**. The support departments are ranked in order of highest cost to lowest cost.

Required:

1. Allocate the costs of the support departments using the sequential method. (Round allocation ratios to four significant digits. Round allocated costs to the nearest dollar.)
2. Using direct labour hours, compute departmental overhead rates. (Round allocation ratios to four significant digits. Round allocated costs to the nearest dollar.)

OBJECTIVE 5

Exercise 7-25 PHYSICAL UNITS METHOD

Alomar Company manufactures four products from a joint production process: colgene, delgene, prosone, and freol. The joint costs for one batch are as follows:

Direct materials	$84,450
Direct labour	42,000
Overhead	23,550

At the split-off point, a batch yields 1,200 colgene, 1,800 delgene, 3,000 prosone, and 3,600 freol. All products are sold at the split-off point: colgene sells for $60 per unit, delgene sells for $75 per unit, prosone sells for $20 per unit, and freol sells for $28.50 per unit.

Carry out all percent calculations to four significant digits.

Required:

1. Allocate the joint costs using the physical units method.
2. Suppose that the products are weighted as follows:

Colgene	3.0
Delgene	4.0
Prosone	0.5
Freol	1.0

Allocate the joint costs using the weighted average method.

Exercise 7-26 SALES-VALUE-AT-SPLIT-OFF METHOD

OBJECTIVE 5

Refer to **Exercise 7-25** and allocate the joint costs using the sales-value-at-split-off method.

Exercise 7-27 NET REALIZABLE VALUE METHOD, DECISION TO SELL AT SPLIT-OFF OR PROCESS FURTHER

OBJECTIVE 5

Pacheco Inc. produces two products, overs and unders, in a single process. The joint costs of this process were $50,000, and 14,000 units of overs and 36,000 units of unders were produced. Separable processing costs beyond the split-off point were as follows: overs, $18,000; unders, $23,040. Overs sell for $2.00 per unit; unders sell for $3.14 per unit.

Required:

1. Allocate the $50,000 joint costs using the estimated net realizable value method.
2. Suppose that overs could be sold at the split-off point for $1.80 per unit. Should Pacheco sell overs at split-off or process them further? Show supporting computations.

Problems

Problem 7-28 ALLOCATION: FIXED AND VARIABLE COSTS, BUDGETED FIXED AND VARIABLE COSTS

OBJECTIVE 2

SERVICE

Biotechtron Inc. has two research laboratories in the Maritimes, one in Bathurst, New Brunswick, and one in Stellarton, New Brunswick. The owner of Biotechtron centralized the legal services function in the Bathurst office and had both laboratories send any legal questions or issues to the Bathurst office. The legal services support centre has budgeted fixed costs of $120,000 per year and a budgeted variable rate of $40 per hour of professional time. The normal usage of the legal services centre is 1,700 hours per year for the Bathurst office and 800 hours per year for the Stellarton office. This corresponds to the expected usage for the coming year.

Required:

1. Determine the amount of legal services support centre costs that should be assigned to each office.
2. Since the offices produce services, not tangible products, what purpose is served by allocating the budgeted costs?
3. Now, assume that during the year, the legal services centre incurred actual fixed costs of $123,000 and actual variable costs of $108,000. It delivered 2,750 hours of professional time—1,650 hours to Bathurst and 1,100 hours to Stellarton. Determine the amount of the legal services centre's costs that should be allocated to each office. Explain the purposes of this allocation.
4. Did the costs allocated differ from the costs incurred by the legal services centre? If so, why?

OBJECTIVE 2 3

Problem 7-29 DIRECT METHOD, VARIABLE VERSUS FIXED COSTING AND PERFORMANCE EVALUATION

SERVICE

AirBorne is a small airline operating out of Sudbury, Ontario. Its three flights travel to Cochrane, Kenora, and Timmins. The owner of the airline wants to assess the full cost of operating each flight. As part of this assessment, the costs of two support departments (maintenance and baggage) must be allocated to the three flights. The two support departments that support all three flights are located in Sudbury (any maintenance or baggage costs at the destination airports are directly traceable to the individual flights). Budgeted and actual data for the year are as follows for the support departments and the three flights:

	Support Centres		Flights		
	Maintenance	Baggage	Cochrane	Kenora	Timmins
Budgeted data:					
Fixed overhead	$240,000	$150,000	$20,000	$18,000	$30,000
Variable overhead	$30,000	$64,000	$5,000	$10,000	$6,000
Hours of flight time*	—	—	2,000	4,000	2,000
Number of passengers	—	—	10,000	15,000	5,000
Actual data:					
Fixed overhead	$235,000	$156,000	$22,000	$17,000	$29,500
Variable overhead	$80,000	$33,000	$6,200	$11,000	$5,800
Hours of flight time	—	—	1,800	4,200	2,500
Number of passengers	—	—	8,000	16,000	6,000

* Normal activity levels.

Round all allocation ratios to four significant digits. Round all allocated amounts to the nearest dollar.

Required:

1. Using the direct method, allocate the support service costs to each flight, assuming that the objective is to determine the cost of operating each flight.
2. Using the direct method, allocate the support service costs to each flight, assuming that the objective is to evaluate performance. Do any costs remain in the two support departments after the allocation? If so, how much? Explain.

OBJECTIVE 3

Problem 7-30 COMPARISON OF METHODS OF ALLOCATION

Haida Pottery Inc. is divided into two operating divisions: Pottery and Retail. The company allocates Power and Human Resources department costs to each operating division. Power costs are allocated on the basis of the number of machine hours and human resources costs on the basis of the number of employees. No effort is made to separate fixed and variable costs; however, only budgeted costs are allocated. Allocations for the coming year are based on the following data:

	Support Departments		Operating Divisions	
	Power	Human Resources	Pottery	Retail
Overhead costs	$150,000	$160,000	$83,600	$47,800
Machine hours	2,000	1,000	3,600	5,400
Number of employees	20	17	60	80

Round all allocation ratios to four significant digits. Round all allocated amounts to the nearest dollar.

Required:

1. Allocate the support service costs using the direct method.
2. Allocate the support service costs using the sequential method. The support departments are ranked in order of highest cost to lowest cost.
3. Allocate the support service costs using the reciprocal method.

Problem 7-31 PHYSICAL UNITS METHOD, RELATIVE SALES VALUE METHOD

OBJECTIVE 5

Allen Petroleum Inc. is a small company that acquires high-grade crude oil from low-volume production wells owned by individuals and small partnerships. The crude oil is processed in a single refinery into Two Oil, Six Oil, and impure distillates. Allen Petroleum does not have the technology or capacity to process these products further and sells most of its output each month to major refineries. There were no beginning finished goods or work-in-process inventories on April 1. The production costs and output of Allen Petroleum for April are as follows:

Crude oil placed into production	$5,000,000
Direct labour and related costs	2,000,000
Manufacturing overhead	3,000,000

Data on barrels produced and selling price:

Two Oil, 300,000 barrels produced; sales price, $25 per barrel
Six Oil, 170,000 barrels produced; sales price, $30 per barrel
Distillates, 80,000 barrels produced; sales price, $16 per barrel

Required:

1. Calculate the amount of joint production cost that Allen Petroleum would allocate to each of the three joint products by using the physical units method. (Carry out the ratio calculation to four decimal places. Round allocated costs to the nearest dollar.)
2. Calculate the amount of joint production cost that Allen Petroleum would allocate to each of the three joint products by using the relative sales value method. (Carry out the ratio calculation to four decimal places. Round allocated costs to the nearest dollar.)

Problem 7-32 FIXED AND VARIABLE COST ALLOCATION

OBJECTIVE 2

SERVICE

Welcome Inns is a chain of motels serving business travellers in Newfoundland. The chain has grown from one motel in 2010 to five motels. In 2013, the owner of the company decided to set up an internal Accounting Department to centralize control of financial information. (Previously, local CAs handled each motel's bookkeeping and financial reporting.) The accounting office was opened in January 2013 by renting space adjacent to corporate headquarters in St. John's. All motels have been supplied with personal computers and modems by which to transfer information to central accounting on a weekly basis.

The Accounting Department has budgeted fixed costs of $135,000 per year. Variable costs are budgeted at $20 per hour. In 2013, actual cost for the Accounting Department was $223,000. Further information is as follows:

	Actual Revenues		Actual Hours of Accounting
	2012	2013	2013
St. John's	$405,000	$420,000	1,475
Corner Brook Roswell	540,000	588,000	410
Mount Pearl	432,000	364,000	620
Come By Chance	648,000	728,000	890
St. Anthony	675,000	700,000	450

Required:

1. Suppose the total actual costs of the Accounting Department are allocated on the basis of 2013 sales revenue. How much will be allocated to each motel?
2. Suppose that Welcome Inns views 2012 sales figures as a proxy for budgeted capacity of the motels. Thus, fixed Accounting Department costs are allocated on the basis of 2012 sales, and variable costs are allocated according to 2013 usage multiplied by the variable rate. How much Accounting Department cost will be allocated to each motel?
3. Comment on the two allocation schemes. Which motels would prefer the method in Requirement 1? The method in Requirement 2? Explain.

OBJECTIVE 2

SERVICE

Problem 7-33 SINGLE CHARGING RATES

House Corporation Board (HCB) of Tri-Gamma Sorority is responsible for the operation of a two-storey sorority house on the Northern University campus. HCB has set a normal capacity of 60 women. At any given point in time, there are 100 members of the chapter: 60 living in the house and 40 living elsewhere (e.g., in the freshman dorms on campus). HCB needs to set rates for the use of the house for the coming year. The following costs are budgeted: $240,000 fixed and $34,800 variable. The fixed costs are fairly insensitive to the number of women living in the house. Food is budgeted at $40,000 and is included in the fixed costs; food does not seem to vary greatly given the stated capacity. The variable expenses consist of telephone bills and some of the utilities. HCB is not responsible for chapter dues, party fees, pledging and initiation fees, and other social expenditures. Women living in the house eat 20 meals per week there and live in a two-person room. (All in-house members' rooms, bathroom facilities, and so on are on the second floor.) All members eat Monday dinner at the house and have full use of house facilities (e.g., the two TV lounges, kitchens, access to milk and cereal at any time, study facilities, and so on).

HCB has traditionally set two rates: one for in-house members and one for out-of-house members. There are 32 weeks in a school year.

Required:

1. Discuss the factors that might go into determining the charging rate for the two types of sorority members.
2. Set charging rates for the in-house and out-of-house members.

CMA Problems

OBJECTIVE 3 4

CMA Problem 7-1 DIRECT METHOD, RECIPROCAL METHOD, OVERHEAD RATES*

Wong Corporation is developing departmental overhead rates based on direct labour hours for its two production departments—Moulding and Assembly. The Moulding Department employs 20 people, and the Assembly Department employs 80 people. Each person in these two departments works 2,000 hours per year. The production-related overhead costs for the Moulding Department are budgeted at $190,000, and the Assembly Department costs are budgeted at $80,000. Two support departments—Engineering and General Factory—directly support the two production departments and have budgeted costs of $216,000 and $370,000, respectively. The production departments' overhead rates cannot be determined until the support departments' costs are properly allocated. The following schedule reflects the use of the Engineering Department's and General Factory Department's output by the various departments.

	Engineering	General Factory	Moulding	Assembly
Engineering hours	—	2,000	2,000	8,000
Square metres	120,000	—	420,000	60,000

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For all requirements, round allocation ratios to four significant digits and round allocated costs to the nearest dollar.

Required:

1. Calculate the overhead rates per direct labour hour for the Moulding Department and the Assembly Department using the direct allocation method to charge the production departments for support department costs.
2. Calculate the overhead rates per direct labour hour for the Moulding Department and the Assembly Department using the reciprocal method to charge support department costs to each other and to the production departments.
3. Explain the difference between the methods, and indicate the arguments generally presented to support the reciprocal method over the direct allocation method. *(CMA adapted)*

CMA Problem 7-2 PHYSICAL UNITS METHOD, RELATIVE SALES-VALUE-AT-SPLIT-OFF METHOD, NET REALIZABLE VALUE METHOD, DECISION MAKING*

OBJECTIVE 5

Sonimad Sawmill Inc. (SSI) purchases logs from independent timber contractors and processes them into the following three types of lumber products:

1. Studs for residential construction (e.g., walls and ceilings)
2. Decorative pieces (e.g., fireplace mantels and beams for cathedral ceilings)
3. Posts used as support braces (e.g., mine support braces and braces for exterior fences around ranch properties)

These products are the result of a joint sawmill process that involves removing bark from the logs, cutting the logs into a workable size (ranging from 3 to 5 metres in length), and then cutting the individual products from the logs, depending upon the type of wood (pine, oak, walnut, or maple) and the size (diameter) of the log.

The joint process results in the following costs and output of products during a typical month:

Joint production costs:	
Materials (rough timber logs)	$ 500,000
Debarking (labour and overhead)	50,000
Sizing (labour and overhead)	200,000
Product cutting (labour and overhead)	250,000
Total joint costs	$1,000,000

Product yield and average sales value on a per-unit basis from the joint process are as follows:

Product	Monthly Output	Fully Processed Sales Price
Studs	75,000	$ 8
Decorative pieces	5,000	100
Posts	20,000	20

The studs are sold as rough-cut lumber after emerging from the sawmill operation without further processing by SSI. Also, the posts require no further processing. The decorative pieces must be planed and further sized after emerging from the SSI sawmill. This additional processing costs SSI $100,000 per month and normally results in a loss of 10 percent of the units entering the process. Without this planing and sizing process, there is still an active intermediate market for the unfinished decorative pieces where the sales price averages $60 per unit.

Required:

1. Based on the information given for Sonimad Sawmill Inc. allocate the joint processing costs of $1,000,000 to each of the three product lines using the:
   a. Relative sales-value-at-split-off method

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b. Physical units method at split-off
c. Estimated net realizable value method

2. Prepare an analysis for Sonimad Sawmill Inc. to compare processing the decorative pieces further as it presently does, with selling the rough-cut product immediately at split-off. Be sure to provide all calculations.
3. Assume Sonimad Sawmill Inc. announced that in six months it will sell the rough-cut product at split-off due to increasing competitive pressure. Identify at least three types of likely behaviour that will be demonstrated by the skilled labour in the planing and sizing process as a result of this announcement. Explain how this behaviour could be improved by management. *(CMA adapted)*

The Collabourative Learning Exercises can be found on the product support site at ***www.hansen1ce.nelson.com****.*

After studying this chapter, you should be able to:

- ➤1 Define budgeting, and discuss its role in planning, controlling, and decision making.
- ➤2 Prepare the operating budget, identify its major components, and explain the interrelationships of the various components.
- ➤3 Identify the components of the financial budget, and prepare a cash budget.
- ➤4 Define flexible budgeting, and discuss its role in planning, control, and decision making.
- ➤5 Define activity-based budgeting, and discuss its role in planning, control, and decision making.
- ➤6 Identify and discuss the key features that a budgetary system should have to encourage managers to engage in goal-congruent behaviour.

CHAPTER 8

Budgeting for Planning and Control

Careful planning, whether formal or informal, is vital to the health of any organization. Business managers must know their resource capabilities and have a plan that shows how those resources will be used. In this chapter, the basics of budgeting are discussed, and traditional master budgets are developed. Flexible and activity-based budgeting are also presented, along with extensive discussion of the behavioural aspects of budgeting and its use in control.

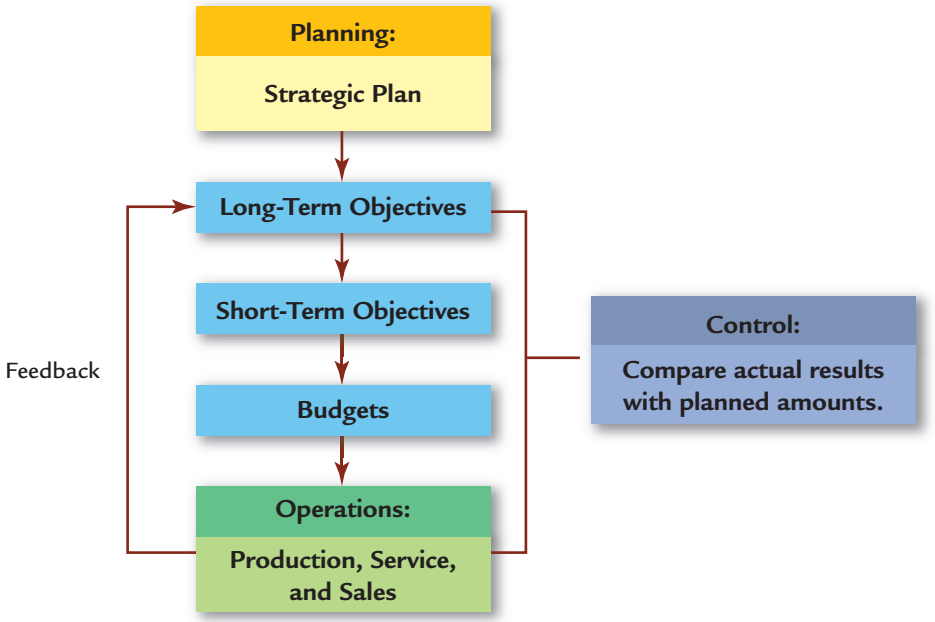
The Role of Budgeting in Planning and Control

OBJECTIVE ➤1
Define budgeting, and discuss its role in planning, controlling, and decision making.

Budgets are quantitative plans for the future, stated in either physical or financial terms or both. Budgeting is critically important to both planning and control. When used for planning, a budget is a method for translating the goals and strategies of an organization into operational terms. **Control** is the process of setting standards, receiving feedback on actual performance, and taking corrective action

Exhibit 8-1

The Master Budget and Its Interrelationships



whenever actual performance deviates significantly from planned performance. Thus, when budgets are used for controlling purposes, a budget is used to compare actual outcomes with budgeted outcomes, and can steer operations back on course, if necessary. This comparison provides feedback both for operations and for future budgets.

Exhibit 8-1 illustrates the relationship of budgets to planning, operations, and control. Budgets evolve from the long-run objectives of the firm; they form the basis for operations.

Purposes of Budgeting

Budgets are usually prepared for organizational units (departments, plants, divisions, and so on). Also, budgets are prepared for activities, (sales, production, research, and so on). This system of budgets serves as the comprehensive financial plan for the entire organization and gives an organization several advantages:

1. It forces managers to plan.
2. It improves communication and coordination among different organizational units and activities.
3. It provides resource information that can be used to improve decision making.
4. It aids in resource allocation and sets benchmarks that can be used for the subsequent evaluation of performance.

Budgeting forces management to plan for the future—to develop an overall direction for the organization, foresee problems, and develop future policies. When managers plan, they grow to understand the capabilities of their businesses and where the resources of the business should be used. All businesses and not-for-profit entities should budget. All large businesses do budget. In fact, the budgeting activity of a company such as **IBM** takes significant amounts of time and involves many managers at a variety of levels. Some small businesses do not budget, and many of those go out of business in short order.

Budgets help managers make better decisions. For example, a cash budget points out potential shortfalls. If a company foresees a cash deficiency, it may want to improve accounts receivable collection or postpone plans to purchase new assets.

Budgets set standards for the use of a company's resources and help control and motivate employees. Businesses with successful budgets ensure that steps are taken to achieve the objectives outlined in an organization's master plan.

Budgets are also used for communication and coordination of employee efforts, so that all employees can be aware of their role in achieving the organization's objectives. This is why explicitly linking the budget to the long-run plans of the organization is so important. The budget is not a series of vague, rosy scenarios, but a set of specific plans to achieve those objectives. Budgets encourage coordination because the various areas and activities of the organization must all work together to achieve the stated objectives. The role of communication and coordination becomes more important as an organization grows larger.

The budgeting process can range from the fairly informal process undergone by a small firm, to an elaborately detailed, several-month procedure employed by large firms. Key features of the process include directing and coordinating the overall budget. Every organization must have someone responsible for directing and coordinating the overall budgeting process. This **budget director** works under the direction of the budget committee and is usually the controller or someone who reports to the controller. The **budget committee** is responsible for reviewing the budget, providing policy guidelines and budgetary goals, resolving differences that may arise as the budget is prepared, approving the final budget, and monitoring the actual performance of the organization as the year unfolds. The budget committee ensures that the budget is linked to the strategic plan of the organization. The president of the organization appoints the members of the committee, who are usually the president, vice presidents, and the controller.

The Budgeting Process

Types of Budgets

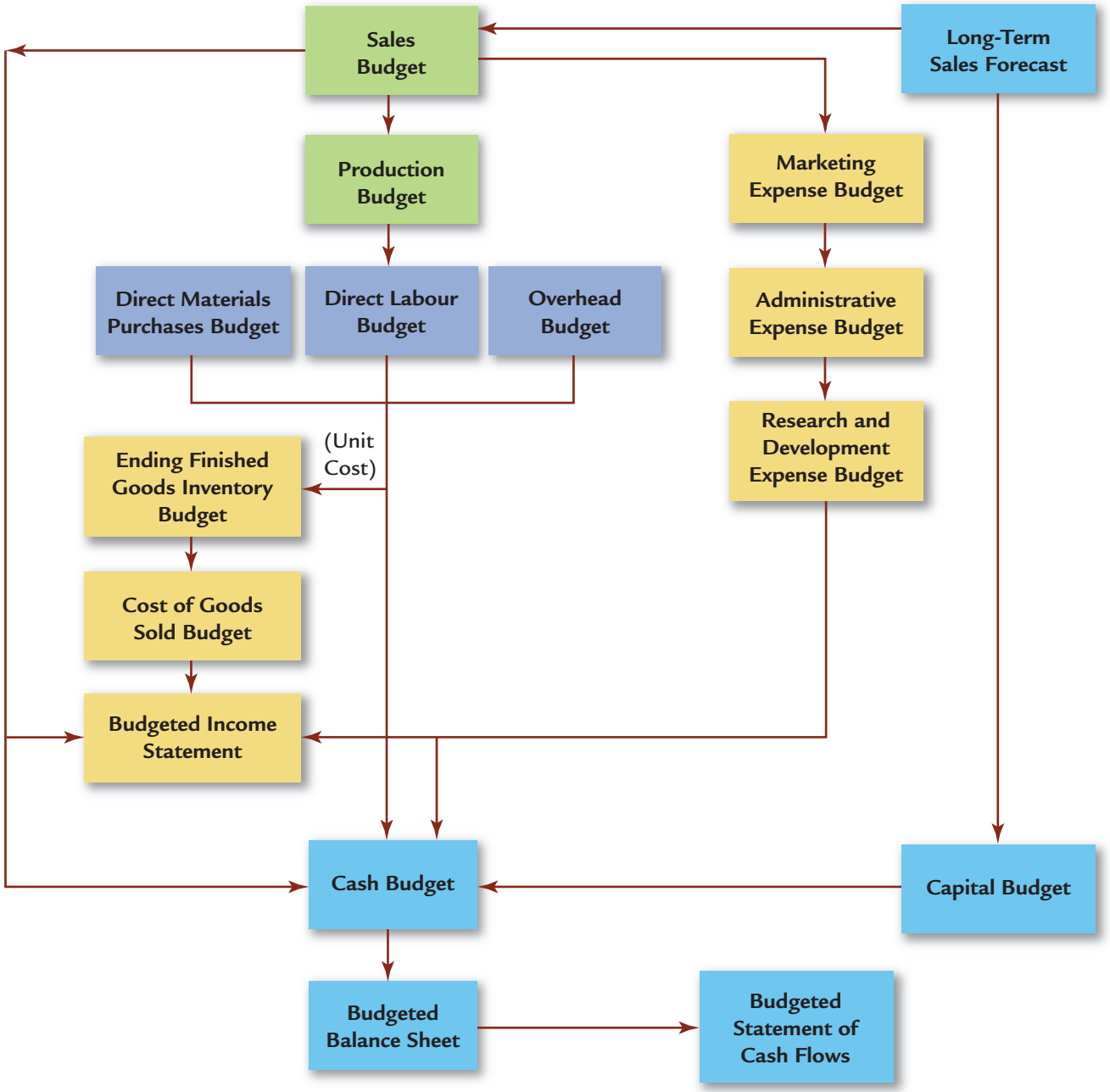
The **master budget** is a comprehensive financial plan made up of various individual departmental and activity annual budgets. A master budget can be divided into *operating* and *financial* budgets. **Operating budgets** are concerned with the income-generating activities of a firm: sales, production, and finished goods inventories. The ultimate outcome of the operating budgets is a pro forma or budgeted income statement. Note that "pro forma" is synonymous with "budgeted" and "estimated." In effect, the pro forma income statement is done "according to form" but with estimated, not historical, data. **Financial budgets** are concerned with the inflows and outflows of cash and with financial position. Planned cash inflows and outflows are detailed in a cash budget, and expected financial position at the end of the budget period is shown in a budgeted, or pro forma, balance sheet. Exhibit 8-2 illustrates the components of the master budget.

The master budget is usually prepared for a one-year period corresponding to the company's fiscal year. The yearly budgets are broken down into quarterly and monthly budgets. Using shorter time periods helps managers compare actual data with budgeted data as the year unfolds. Because progress can be checked more frequently, problems can be identified and handled before they become serious.

Most organizations prepare the budget for the coming year during the last four or five months of the current year. However, some organizations have developed a continuous budgeting philosophy. A **continuous** (or **rolling**) **budget** is a moving 12-month budget. As a month expires in the budget, an additional month in the future is added so that the company always has a 12-month plan on hand. Proponents of continuous budgeting maintain that it forces managers to plan ahead constantly. The majority of CFOs believe that rolling forecasts are very valuable, and

Exhibit 8-2

Components of the Master Budget



companies that do use them typically roll the forecasts out for five or six quarters rather than four.[1]

Similar to a continuous budget is *a continuously updated budget*. The objective of this budget is not to have 12 months of budgeted information at all times, but instead to update the master budget each month as new information becomes available. For example, every autumn, Chandler Engineering prepares a budget for the coming year. Then at the end of each month of the year, the budget is transformed into a rolling forecast by recording year-to-date results and the forecast for the

[1] Omar Aguilar, "How Strategic Performance Management Is Helping Companies Create Business Value," *Strategic Finance* (January 2003): 44–49.

remainder of the year. In essence, the budget is continually updated throughout the year.

Technological advances permit companies to keep much closer track of sales and production needs throughout the year. **Revlon** has adopted a new computer system that manages sales data for each item in each store. It can track sales as specifically as by colour of nail polish. This faster, better information allows Revlon to adjust budgets continually throughout the year. As a result, the company can manage operations by cutting the production and shipment of slow-selling cosmetics and ramping up production of the hot sellers.[2]

Gathering Information for Budgeting

At the beginning of the master budgeting process, the budget director alerts all segments of the company to begin gathering budget information. The data used to create the budget come from many sources. Historical data are one possibility. For example, last year's direct materials costs may give the production manager a good feel for potential materials costs for next year. Still, historical data alone cannot tell a company what to expect in the future.

Forecasting Sales The sales forecast is the basis for the sales budget, which, in turn, is the basis for all of the other operating budgets and most of the financial budgets. Accordingly, the accuracy of the sales forecast strongly affects the soundness of the entire master budget.

Creating the sales forecast is usually the responsibility of the Marketing Department. One approach is for the chief sales executive to have individual salespeople submit sales predictions, which are aggregated to form a total sales forecast. The accuracy of this sales forecast may be improved by considering other factors such as the general economic climate, competition, advertising, pricing policies, and so on. Some companies supplement the Marketing Department forecast with more formal approaches, such as time-series analysis, correlation analysis, econometric modelling, and industry analysis.

To illustrate an actual sales forecasting approach, consider the practices of a company that manufactures oil field equipment on a job-order basis. Each month, the Finance and Sales departments' heads meet to construct a sales forecast based on bookings. A booking is a probable sales order submitted by sales personnel in the field; it is meant to alert the Engineering and Manufacturing departments to a potential job. Past experience has shown that bookings are generally followed by sales/shipments within 30 to 45 days. Exhibit 8-3 shows the short-term bookings forecast for the company. Notice that the dollar amount of each booking is multiplied by its probability of occurrence to obtain a weighted dollar amount. The sum of weighted amounts is the forecast for sales for the month. The probability estimate is determined jointly by the salesperson and the controller. Each probability is initially set at 50 percent. Then, it is adjusted upward or downward based on any additional information about the sale. The probability is really a prediction of a compound event: the prediction of both getting the order and determining the month in which it will happen. The Sales Department tends toward overconfidence—both in terms of getting the order and in landing it sooner rather than later. Thus, the controller takes a more pessimistic view and modifies the forecast. The end result is the form shown in the exhibit.

Forecasting Other Variables Sales are not the only concern in budgeting. Costs and cash-related items are critical. Many of the same factors considered in sales forecasting apply to cost forecasting. Here, historical amounts can be of real value. Managers can adjust past figures based on their knowledge of coming events. For example, a three-year union contract takes much of the uncertainty out of wage prediction.

[2] Emily Nelson, "Revlon Chief Banks on Risky Strategy as He Seeks New Image for Ailing Firm," *The Wall Street Journal* (November 21, 2000): B1.

Exhibit 8-3

Short-Term Bookings Forecast for Oil Field Equipment Company

Quote #	Region/ Country	Customer	Product	Dollar Amount	Probability	Weighted Month Total
March 2013						
1194-17	Spain	Valencia	repair 3224	$ 37,500	100%	$ 37,500
1294-03	Bulgaria	Luecim	1256, 7188	74,145	80	59,316
0195-55	USA	Exxon	4498	25,000	95	23,750
0295-19	USA	BP/TX	6766, 1267	150,442	100	150,442
0295-23	China	China Res	7541, 8875	55,900	75	41,925
0295-45	China	China Res	8879, 0944	34,500	80	27,600
0395-36	Abu Dhabi	ADES	7400, 6751, 5669 & spares	30,000	50	15,000
March Total						$355,533
April 2013						
1294-14	China	Jiang Han	6524, 5523, 0412, 4578, 3340	$234,000	80%	$187,200
0295-43	Russia	Geoserv	3356	76,800	60	46,080
0295-10	Venezuela	Petrolina	4450, 6713, 7122	112,500	90	101,250
0395-37	Indonesia	Chevron	8890, 0933	98,000	65	63,700
0395-71	Italy	CV International	7815	16,000	70	11,200
April Total						$409,430
May 2013						
0295-21	Mexico	Instituto Mexicana	8900 & spares	$ 34,000	40%	$ 13,600
0395-29	Venezuela	Petrolina	8416, 8832	165,000	50	82,500
0495-11	USA	Branchwater Inc.	9043, 8891	335,000	60	201,000
0495-68	Saudi Arabia	Aramco	0453	3,500	50	1,750
May Total						$298,850

(Of course, if the contract is expiring, the uncertainty returns.) Alert purchasing agents will have an idea of changing materials prices. In fact, large companies such as **Nestlé** and the **Coca-Cola Company** have entire departments devoted to the forecasting of commodity prices and supplies. They invest in commodity futures to smooth out price fluctuations, an action that facilitates budgeting. Overhead is broken down into its component costs; these can be predicted using past data and relevant inflation figures.

The cash budget is a critically important part of the master budget, and some of its components, especially payment of accounts receivable, also require forecasting. This is discussed in more detail in the section on cash budgeting.

OBJECTIVE 2

Prepare the operating budget, identify its major components, and explain the interrelationships of the various components.

Preparing the Operating Budget

The first section of the master budget is the operating budget. It consists of a series of schedules for all phases of operations, culminating in a pro forma income statement. The following are the components of the operating budget.

1. Sales budget
2. Production budget
3. Direct materials purchases budget
4. Direct labour budget
5. Overhead budget
6. Ending finished goods inventory budget
7. Cost of goods sold budget
8. Marketing expense budget
9. Research and development expense budget
10. Administrative expense budget
11. Pro forma income statement

You may want to refer back to Exhibit 8-2 to see how these components of the operating budget fit into the master budget.

The example used to illustrate the components of the operating budget is based on ABT Inc. a manufacturer of concrete block and pipe for the construction industry. For simplicity, we will prepare the operating budget for ABT's concrete block line. (The budget for the pipe product line is prepared in the same way and merged into the overall company budget.)

Sales Budget

The **sales budget** is the projection approved by the budget committee that describes expected sales for each product in units and dollars. The sales budget must be constructed first, before other budgets can be constructed.

Cornerstone 8-1 illustrates the sales budget for ABT's concrete block line. The sales budget reveals that ABT's sales fluctuate seasonally. Most sales (75 percent) take place in the spring and summer. Also, note that ABT expects price to increase from $0.70 to $0.80 in the summer quarter. Because of the price change within the year, an average price must be used for the column that describes the total year's activities ($0.75 = $12,000,000/16,000,000 units). If ABT has two types of concrete blocks, a separate sales budget would be prepared for each type. This is shown in Requirement 2 of Cornerstone 8-1.

Production Budget

The **production budget** describes how many units must be produced in order to meet sales needs and satisfy ending inventory requirements. The production budget depends on the unit sales shown in the sales budget.

A separate production budget is constructed for each product manufactured (or service provided). Both unit sales and unit finished goods inventories desired are required for the production budget. The basic equation for the production budget is:

$$\text{Units to be produced} = \text{Desired units in ending inventory} + \text{Unit sales} - \text{Units in beginning inventory}$$

Of course, if there were no inventories, the number of units to be produced would equal the number of units to be sold. In service firms, units of service provided equal the units of service sold since services are not inventories. Similarly, in the JIT firm, units sold equal units produced, since a customer order triggers production. The production budget must, however, consider the existence of beginning and ending inventories. Notice that the production budget is expressed in terms of units; we do not yet know how much they will cost. Cornerstone 8-2 shows how and why a production budget is constructed.

Direct Materials Purchases Budget

After the production budget is completed, budgets for direct materials, direct labour, and overhead can be prepared. The **direct materials purchases budget** is similar in format to the production budget; it is based on the amount of materials needed for production and the inventories of direct materials.

Expected direct materials usage is determined by the input-output relationship (the technical relationship existing between direct materials and output). This relationship is often determined by the Engineering Department or the industrial designer. For example, one lightweight concrete block requires approximately 2.6 kilograms of materials (cement, sand, gravel, shale, pumice, and water). The relative mix of these ingredients is fixed for a specific kind of concrete block. Thus, it is fairly easy to determine expected usage for each material from the production budget by multiplying the amount of material needed per unit of output times the number of units of output.

CORNERSTONE 8-1

The HOW and WHY of Constructing a Sales Budget

Information:

ABT Inc. manufactures and sells concrete block for residential and commercial building. ABT expects to sell the following next year, in 2013:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Units	2,000,000	6,000,000	6,000,000	2,000,000
Unit selling price	$0.70	$0.70	$0.80	$0.80

Why:

The sales budget is the foundation for the master budget; all other budgets are based in part on the units sold or revenue given in the sales budget.

Required:

1. Construct a sales budget for the ABT concrete block line for the coming year. Show total sales by quarter and in total for the year.
2. ***What if*** there were two types of concrete block (type 1 and type 2) and that 60 percent of the sales in each quarter were for type 1? Assume the selling price for type 1 is $0.60 in the first quarter and $0.70 for the rest of the year. The selling price of type 2 is $0.80 in Quarters 1 and 2 and is $0.90 per unit for the rest of the year. Construct a sales budget for ABT showing sales for both types and in total.

Solution:

1.

Sales Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units	2,000,000	6,000,000	6,000,000	2,000,000	16,000,000
Unit selling price	× $0.70	× $0.70	× $0.80	× $0.80	× $0.75
Sales	$1,400,000	$4,200,000	$4,800,000	$1,600,000	$12,000,000

2.

Sales Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Type 1 block[1]					
Units	1,200,000	3,600,000	3,600,000	1,200,000	9,600,000
Unit selling price	× $0.60	× $0.70	× $0.70	× $0.70	× $0.6875[2]
Sales	$ 720,000	$2,520,000	$2,520,000	$ 840,000	$ 6,600,000
Type 2 block[3]					
Units	800,000	2,400,000	2,400,000	800,000	6,400,000
Unit selling price	× $0.80	× $0.80	× $0.90	× $0.90	× $0.85[4]
Sales	$ 640,000	$1,920,000	$2,160,000	$ 720,000	$ 5,440,000
Total sales	$1,360,000	$4,440,000	$4,680,000	$1,560,000	$12,040,000

[1] Units in each quarter equal 60% of the unit sales in Requirement 1.
[2] Average price for the year = $6,600,000/9,600,000 = $0.6875
[3] Units in each quarter equal 40% of the unit sales in Requirement 1.
[4] Average price for the year = $5,440,000/6,400,000 = $0.85

The HOW and WHY of Constructing a Production Budget

CORNERSTONE 8-2

Information:

ABT expects the following unit sales and desired ending inventory next year, in 2013:

Quarter	Unit Sales	Ending Inventory
1	2,000,000	500,000
2	6,000,000	500,000
3	6,000,000	100,000
4	2,000,000	100,000

Inventory on both January 1, 2013, and January 1, 2014, is expected to be 100,000 blocks.

Why:

The production budget is needed to tell production how much to produce in the coming year. The number of units produced will be used to determine budgeted costs for direct materials, direct labour, and overhead.

Required:

1. Construct a production budget for the ABT concrete block line for the coming year. Show total units produced by quarter and in total for the year.
2. ***What if*** ABT did not provide the desired ending inventory in units, but instead relied on an inventory rule—that the desired ending inventory of blocks was equal to 5 percent of the next period's sales? Further, assume that the budgeted unit sales in Quarter 1, 2014, equalled 2,500,000, and that the beginning inventory for Quarter 1, 2013, met the inventory rule. Construct a production budget for ABT showing units produced by quarter and in total for the year.

Solution:

1.

Production Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Unit sales	2,000,000	6,000,000	6,000,000	2,000,000	16,000,000
Desired ending inventory	500,000	500,000	100,000	100,000	100,000
Total needed	2,500,000	6,500,000	6,100,000	2,100,000	16,100,000
Less: Beginning inventory*	100,000	500,000	500,000	100,000	100,000
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000

*Beginning inventory for Quarter 1 is given. Beginning inventory for the succeeding quarters is equal to the ending inventory of the previous quarter. That is, beginning inventory for Quarter 2 is equal to desired ending inventory for Quarter 1.

Notice that desired ending inventory for the year equals the desired ending inventory for Quarter 4. Beginning inventory for the year equals the beginning inventory for Quarter 1.

2. If desired ending inventory of blocks equals 5 percent of the next quarter's sales, then the desired ending inventory for each quarter is as follows:

Quarter 1 ending inventory $= 0.05 \times 6{,}000{,}000 = 300{,}000$

Quarter 2 ending inventory $= 0.05 \times 6{,}000{,}000 = 300{,}000$

Quarter 3 ending inventory $= 0.05 \times 2{,}000{,}000 = 100{,}000$

Quarter 4 ending inventory $= 0.05 \times 2{,}500{,}000 = 125{,}000$

CORNERSTONE 8-2 *(continued)*

Production Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Unit sales	2,000,000	6,000,000	6,000,000	2,000,000	16,000,000
Desired ending inventory	300,000	300,000	100,000	125,000	125,000
Total needed	2,300,000	6,300,000	6,100,000	2,125,000	16,125,000
Less: Beginning inventory*	100,000	300,000	300,000	100,000	100,000
Units produced	2,200,000	6,000,000	5,800,000	2,025,000	16,025,000

*Beginning inventory for Quarter 1 = Ending inventory for Quarter 4 of 2012.
Desired ending inventory for Quarter 4, 2012 = 0.05 × 2,000,000 = 100,000

Notice that desired ending inventory for the year equals the desired ending inventory for Quarter 4. Beginning inventory for the year equals the beginning inventory for Quarter 1.

Once expected usage is computed, the purchases (in units) are computed as follows:

Purchases = Desired ending inventory of direct materials + Expected usage − Beginning inventory of direct materials

The quantity of direct materials in inventory is determined by the firm's inventory policy. Cornerstone 8-3 shows how and why to prepare the direct materials purchases budget. For simplicity, all materials are treated jointly (as if there were only one material input). In reality, a separate direct materials purchases budget would be needed for each kind of material.

Direct Labour Budget

The **direct labour budget** shows the total direct labour hours and direct labour cost needed for the number of units in the production budget. As with direct materials, the usage of direct labour is determined by the technological relationship between labour and output. For example, if a batch of 100 concrete blocks requires 1.5 direct labour hours, then the direct labour time per block is 0.015 hour (1.5/100). Assuming that direct labour is used efficiently, this rate is fixed for the existing technology. The relationship will change only if a new approach to manufacturing is introduced. Cornerstone 8-4 shows how and why to prepare a direct labour budget.

In the direct labour budget, the wage rate used is the *average* wage paid the direct labourers associated with production. Since it is an average, it allows for the possibility of differing wage rates paid to individual labourers. However, if there were different categories of workers, with differing skill levels and wage rates, separate direct labour budgets may be prepared for each category of worker.

Overhead Budget

The **overhead budget** shows the expected cost of all indirect manufacturing items. Unlike direct materials and direct labour, there is no readily identifiable input-output relationship for overhead items. Recall, however, that overhead consists of two types of costs: variable and fixed. Past experience can be used as a guide to determine how overhead varies with activity level. Items that vary with activity level are identified (e.g., supplies and utilities used for production machinery), and the amount that is expected to be spent for each item per unit of activity is estimated. Individual rates

The HOW and WHY of Constructing a Direct Materials Purchases Budget

CORNERSTONE 8-3

Information:

ABT makes concrete blocks. Each block requires 26 kilograms of raw materials (a mixture of cement, sand, gravel, shale, pumice, and water). ABT's raw materials inventory policy is to have 5 million kilograms in ending inventory for the third and fourth quarters and 8 million kilograms in ending inventory for the first and second quarters. Thus, desired direct materials inventory on both January 1, 2013, and January 1, 2014, is 5 million kilograms of materials. Each kilogram of raw materials costs $0.01.

Recall from Cornerstone 8-2 that ABT budgeted 2,400,000 units in Quarter 1; 6,000,000 units in Quarter 2; 5,600,000 units in Quarter 3; and 2,000,000 units in Quarter 4.

Why:

The direct materials purchases budget is constructed for each type of direct material used in production. It tells managers the amount and cost of purchases to support the production budget for the coming year. Dollar purchases will be used later in disbursements under the cash budget.

Required:

1. Construct a direct materials purchases budget for the raw materials for the ABT concrete block line for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** ABT did not provide the desired ending inventory in units, but instead relied on an inventory rule—that the desired ending inventory of raw materials was equal to 2 percent of the next period's production needs? Further, assume that the budgeted production for Quarter 1, 2014, equalled 2,200,000 concrete blocks, and that the beginning inventory of materials for Quarter 1, 2013, met the inventory rule. Construct a direct materials purchases budget showing kilograms purchased and purchase cost by quarter and in total for the year.

Solution:

1.

Direct Materials Purchases Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000
Direct materials per unit	× 26	× 26	× 26	× 26	× 26
Production needs (kg)	62,400,000	156,000,000	145,600,000	52,000,000	416,000,000
Desired ending inventory (kg)	8,000,000	8,000,000	5,000,000	5,000,000	5,000,000
Total needed	70,400,000	164,000,000	150,600,000	57,000,000	421,000,000
Less: Beginning inventory*	5,000,000	8,000,000	8,000,000	5,000,000	5,000,000
Units produced	65,400,000	156,000,000	142,600,000	52,000,000	416,000,000
Cost per kilogram	× $0.01	× $0.01	× $0.01	× $0.01	× $0.01
Total purchase cost	$ 654,000	$ 1,560,000	$ 1,426,000	$ 520,000	$ 4,160,000

*Beginning inventory for Quarter 1 is given. Beginning inventory for the succeeding quarters is equal to the ending inventory of the previous quarter. That is, beginning inventory for Quarter 2 is equal to desired ending inventory for Quarter 1.

CORNERSTONE 8-3 *(continued)*

Notice that desired ending inventory for the year equals the desired ending inventory for Quarter 4. Beginning inventory for the year equals the beginning inventory for Quarter 1.

2. If desired ending inventory of blocks equals 2 percent of the next quarter's production needs, then the desired ending inventory of raw materials for each quarter is as follows:

Quarter 1 ending inventory $= 0.02 \times (26 \times 6{,}000{,}000) = 3{,}120{,}000$
Quarter 2 ending inventory $= 0.02 \times (26 \times 5{,}600{,}000) = 2{,}912{,}000$
Quarter 3 ending inventory $= 0.02 \times (26 \times 2{,}000{,}000) = 1{,}040{,}000$
Quarter 4 ending inventory $= 0.02 \times (26 \times 2{,}200{,}000) = 1{,}144{,}000$

Direct Materials Purchases Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000
Direct materials per unit	× 26	× 26	× 26	× 26	× 26
Production needs (kg)	62,400,000	156,000,000	145,600,000	52,000,000	416,000,000
Desired ending inventory (kg)	3,120,000	2,912,000	1,040,000	1,144,000	1,144,000
Total needed	65,520,000	158,912,000	146,640,000	53,144,000	417,144,000
Less: Beginning inventory*	1,248,000	3,120,000	2,912,000	1,040,000	1,248,000
Units produced	64,272,000	155,792,000	143,728,000	52,104,000	415,896,000
Cost per kilogram	× $0.01	× $0.01	× $0.01	× $0.01	× $0.01
Total purchase cost	$ 642,720	$ 1,557,920	$ 1,437,280	$ 521,040	$ 4,158,960

*Beginning inventory for Quarter 1= 0.02 × (26 × 2,400,000) = 1,248,000. Beginning inventory for the succeeding quarters = the ending inventory of the previous quarter. That is, beginning inventory for Quarter 2 = desired ending inventory for Quarter 1.

Notice that desired ending inventory for the year equals the desired ending inventory for Quarter 4. Beginning inventory for the year equals the beginning inventory for Quarter 1.

are then totalled to obtain a variable overhead rate. Cornerstone 8-5 shows how and why to prepare an overhead budget.

Ending Finished Goods Inventory Budget

The **ending finished goods inventory budget** supplies information needed for the balance sheet and also serves as an important input for the preparation of the cost of goods sold budget. To prepare this budget, the unit cost of producing each concrete block must be calculated using information from Cornerstones 8-2, 8-3, 8-4, and 8-5. Cornerstone 8-6 shows how and why to prepare the ending finished goods inventory budget.

Cost of Goods Sold Budget

Once the ending finished goods inventory budget is finished, it is possible to construct a cost of goods sold budget. This budget will be used in preparing the budgeted income statement later on. Cornerstone 8-7 shows how and why to prepare a cost of goods sold budget.

The HOW and WHY of Constructing a Direct Labour Budget

CORNERSTONE 8-4

Information:

ABT makes concrete blocks. Each block requires 0.015 direct labour hour; direct labour is paid $14 per direct labour hour.

Recall from Cornerstone 8-2 that ABT budgeted 2,400,000 units in Quarter 1; 6,000,000 units in Quarter 2; 5,600,000 units in Quarter 3; and 2,000,000 units in Quarter 4.

Why:

The direct labour budget is constructed for each type of direct labour used in production. It tells managers the amount and cost of direct labour needed to support the production budget for the coming year. Dollar direct labour costs will be used later in disbursements under the cash budget.

Required:

1. Construct a direct labour budget for the ABT concrete block line for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** ABT required two types of direct labour—mixers and shapers. Each concrete block requires 0.005 hour of mixing time at $10 per direct labour hour. Each concrete block requires 0.01 hour of shaping time at $16 per direct labour hour. Prepare a direct labour budget for each type of labour. Show hours and cost for each quarter and in total for the year.

Solution:

1.

Direct Labour Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000
Direct labour per unit	× 0.015	× 0.015	× 0.015	× 0.015	× 0.015
Direct labour hours needed	36,000	90,000	84,000	30,000	240,000
Cost per direct labour hour	× $14	× $14	× $14	× $14	× $14
Total direct labour cost	$ 504,000	$1,260,000	$1,176,000	$ 420,000	$ 3,360,000

2.

Direct Labour Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Type 1 labour					
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000
Mixing labour per unit	× 0.005	× 0.005	× 0.005	× 0.005	× 0.005
Mixing hours needed	12,000	30,000	28,000	10,000	80,000
Cost per mixing hour	× $10	× $10	× $10	× $10	× $10
Total mixing labour cost	$ 120,000	$ 300,000	$ 280,000	$ 100,000	$ 800,000
Type 2 labour					
Units produced	2,400,000	6,000,000	5,600,000	2,000,000	16,000,000
Shaping labour per unit	× 0.01	× 0.01	× 0.01	× 0.01	× 0.01
Shaping hours needed	24,000	60,000	56,000	20,000	160,000
Cost per shaping hour	× $16	× $16	× $16	× $16	× $16
Total shaping labour cost	$ 384,000	$ 960,000	$ 896,000	$ 320,000	$ 2,560,000
Total direct labour cost	$ 504,000	$1,260,000	$1,176,000	$ 420,000	$ 3,360,000

CORNERSTONE 8-5

The HOW and WHY of Constructing an Overhead Budget

Information:

ABT makes concrete blocks. Each block requires 0.015 direct labour hour. Variable overhead is $8 per direct labour hour. Fixed overhead is budgeted at $320,000 per quarter ($100,000 for supervision, $200,000 for depreciation, and $20,000 for rent). Recall from Cornerstone 8-4 that ABT budgeted 36,000 direct labour hours in Quarter 1; 90,000 direct labour hours in Quarter 2; 84,000 direct labour hours in Quarter 3; and 30,000 direct labour hours in Quarter 4.

Why:

The overhead budget is prepared based on variable and fixed overhead used in production. It tells managers the cost of overhead needed to support the production budget for the coming year. Dollar overhead costs will be used later in disbursements under the cash budget.

Required:

1. Construct an overhead budget for the ABT concrete block line for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** ABT's fixed overhead were $350,000 per quarter? How would that affect variable overhead? Fixed overhead? Total overhead?

Solution:

1.

Overhead Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Budgeted direct labour hours	36,000	90,000	84,000	30,000	240,000
Variable overhead rate	× $8	× $8	× $8	× $8	× $8
Budgeted variable overhead	$288,000	$ 720,000	$672,000	$240,000	$1,920,000
Budgeted fixed overhead	320,000	320,000	320,000	320,000	1,280,000
Total overhead cost	$608,000	$1,040,000	$992,000	$560,000	$3,200,000

2. If fixed overhead increased to $350,000 per quarter, variable overhead would be unaffected. However, the fixed overhead amounts would increase from $320,000 to $350,000 per quarter, and the total overhead would increase by $30,000 per quarter. The yearly overhead would increase by $120,000 (4 × $30,000).

Marketing Expense Budget

The next budget to be prepared—the **marketing expense budget**—outlines planned expenditures for selling and distribution activities. As with overhead, marketing expenses can be broken into fixed and variable components. Such items as sales commissions, freight, and supplies vary with sales activity. Salaries of the marketing staff, depreciation on office equipment, and advertising are fixed expenses. The marketing expense budget is illustrated in Cornerstone 8-8.

Administrative Expense Budget

The final budget to be developed for operations is the administrative expense budget. Like the research and development or marketing expense budgets, the **administrative expense budget** consists of estimated expenditures for the overall organization and

The HOW and WHY of Preparing the Ending Finished Goods Inventory Budget

CORNERSTONE 8-6

Information:

ABT makes concrete blocks. Cornerstone 8-3 shows that each unit (block) requires 26 kilograms of raw materials costing $0.01 per kilogram. Therefore, each unit has budgeted direct materials cost of $0.26. Cornerstone 8-4 shows the budgeted direct labour hours per unit (0.015 hour) and wage rate ($14 per direct labour hour). Cornerstone 8-5 shows the budgeted variable overhead per unit ($8 × 0.015 direct labour hour) and total fixed overhead for the year ($1,280,000). Recall from Cornerstone 8-2 that 16,000,000 units were expected to be produced during the year and that 100,000 units were budgeted for ending finished goods inventory.

Why:

The finished goods inventory budget is needed in order to prepare the cost of goods sold budget. It relies on information from the production, direct materials purchases, direct labour, and overhead budgets.

Required:

1. Prepare an ending finished goods inventory budget for ABT for the year.
2. ***What if*** the ending inventory of blocks increased to 120,000? How would that affect the ending finished goods inventory budget?

Solution:

1.

Unit costs:	
Direct materials	$0.26
Direct labour (0.015 × $14)	0.21
Overhead:	
Budgeted variable overhead	0.12
Budgeted fixed overhead*	0.08
Total cost per unit	$0.67

*Fixed overhead per unit = $1,280,000/16,000,000 = $0.08

Total ending inventory cost = Units ending inventory × Unit cost
= 100,000 × $0.67 = $67,000

2. If the number of units in ending inventory increases, the cost of ending inventory will also increase. If there are 120,000 units in ending inventory, the cost of ending finished goods inventory will be $80,400 (120,000 × $0.67).

operation of the company. Most administrative expenses are fixed with respect to sales. They include salaries, depreciation on the headquarters building and equipment, legal and auditing fees, and so on. Cornerstone 8-9 shows how and why to prepare the administrative expense budget.

Additional Operating Budgets

Companies may have other major departments that require a budget that is part of the master budget. One such budget is the **research and development expense budget**, which contains planned expenditures for a separate department devoted to new product research and development. If a company has such a department, the budgeted expenditures are presented in a format very similar to that of the administrative expense budget illustrated in Cornerstone 8-9. There would probably be no

CORNERSTONE 8-7

The HOW and WHY of Preparing the Cost of Goods Sold Budget

Information:

ABT makes concrete blocks. Cornerstone 8-3 shows the total budgeted direct materials cost ($4,160,000). Cornerstone 8-4 shows the budgeted total direct labour cost ($3,360,000). Cornerstone 8-5 shows the budgeted total overhead for the year ($3,200,000). Recall from Cornerstone 8-6 that the cost of ending finished goods inventory is budgeted at $67,000. ABT also provided the information that beginning finished goods inventory is $55,000.

Why:

The cost of goods sold budget shows the budgeted manufacturing costs used to make the units that are expected to be sold. The budgeted cost of goods sold will be used as an input to the budgeted income statement.

Required:

1. Prepare a cost of goods sold budget for ABT for the year.
2. ***What if*** the beginning inventory of finished goods was $60,000? How would that affect the cost of goods sold budget?

Solution:

1.

Direct materials	$ 4,160,000
Direct labour	3,360,000
Overhead	3,200,000
Total manufacturing cost	10,720,000
Add: Beginning inventory, finished goods	55,000
Less: Ending inventory, finished goods	67,000
Cost of goods sold	$10,708,000

2. If the cost of beginning inventory of finished goods increases, the cost of goods sold will also increase. If the cost of beginning inventory of finished goods is $60,000, cost of goods sold would increase to $10,713,000.

variable expense for that budget as it is unlikely that it varies with sales or units produced. As a result, the expenses would be fixed, changing only with management discretion. Of course, companies without a research and development department will not have this budget. Our example company, ABT Inc. does not have a research and development budget.

Budgeted Income Statement

With the completion of the administrative expense schedule, all the operating budgets needed to prepare an estimate of operating income have been completed. The budgeted income statement is shown in Cornerstone 8-10.

Operating income is *not* equivalent to the net income of a firm. To yield net income, interest expense and taxes must be subtracted from operating income. The interest expense paid is taken from the cash budget (shown later in Cornerstone 8-12). The taxes owed depend on the current tax laws.

The HOW and WHY of Constructing a Marketing Expense Budget

CORNERSTONE 8-8

Information:

ABT's only variable marketing expense is a $0.05 commission per unit (block) sold. Fixed marketing expenses for each quarter include the following:

Salaries	$20,000
Depreciation	5,000
Travel	3,000

Advertising expense is $10,000 in Quarters 1, 3, and 4. However, at the beginning of the summer building season, ABT increases advertising; in Quarter 2, advertising expense is $15,000.

Why:

The marketing expense budget is prepared to help the sales and marketing managers understand the expected costs of selling and distribution for the coming year. The total marketing expense will be used later in preparing the budgeted income statement.

Required:

1. Construct a marketing expense budget for the ABT concrete block line for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** ABT's variable marketing expense per unit increased to $0.06? How would that affect variable marketing expense? Fixed marketing expense? Total marketing expense?

Solution:

1.

Marketing Expense Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Budgeted unit sales	2,000,000	6,000,000	6,000,000	2,000,000	16,000,000
Unit variable marketing expense	× $0.05	× $0.05	× $0.05	× $0.05	× $0.05
Total variable marketing expense	$ 100,000	$ 300,000	$ 300,000	$ 100,000	$ 800,000
Fixed marketing expense:					
Salaries	20,000	20,000	20,000	20,000	80,000
Depreciation	5,000	5,000	5,000	5,000	20,000
Travel	3,000	3,000	3,000	3,000	12,000
Advertising	10,000	15,000	10,000	10,000	45,000
Total fixed expense	38,000	43,000	38,000	38,000	157,000
Total marketing expense	$ 138,000	$ 343,000	$ 338,000	$ 138,000	$ 957,000

2. If the sales commision rises to $0.06, total variable marketing expense for the year will increase to $960,000 ($0.06 × 16,000,000 units). Fixed marketing expense will be unaffected. Total marketing expense will increase to $1,117,000.

CORNERSTONE 8-9

The HOW and WHY of Constructing an Administrative Expense Budget

Information:

ABT has no variable administrative expense. Fixed administrative expenses for each quarter include the following:

Salaries	$35,000
Insurance	4,000
Depreciation	12,000
Travel	2,000

Why:

The administrative expense budget is prepared to help managers understand the expected costs of running the company for the coming year. The total administrative expense will be used later in preparing the budgeted income statement.

Required:

1. Construct an administrative expense budget for the ABT concrete block line for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** ABT sold equipment with quarterly depreciation of $1,000 (and did not replace it) at the beginning of Quarter 3? How would that affect quarterly administrative expense? Total administrative expense for the year?

Solution:

1.

Administrative Expense Budget
For the Year Ended December 31, 2013

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Salaries	$35,000	$35,000	$35,000	$35,000	$140,000
Insurance	4,000	4,000	4,000	4,000	16,000
Depreciation	12,000	12,000	12,000	12,000	48,000
Travel	2,000	2,000	2,000	2,000	8,000
Total administrative expense	$53,000	$53,000	$53,000	$53,000	$212,000

2. The sale of equipment at the beginning of Quarter 3 will reduce depreciation in Quarters 3 and 4 by $1,000. Thus, total administrative expense in those two quarters will decrease by $1,000. Total administrative expense for the year will decrease by $2,000.

Operating Budgets for Merchandising and Service Firms

While the budgets in the master budget described previously are widely used in manufacturing firms, the special needs of service and merchandising firms deserve mention.

In a merchandising firm, the production budget is replaced with a merchandise purchases budget. This budget identifies the quantity of each item that must be purchased for resale, the unit cost of the item, and the total purchase cost. The format is

The HOW and WHY of Constructing a Budgeted Income Statement

CORNERSTONE 8-10

Information:

Recall from Cornerstone 8-1 that ABT sales for the year total $12,000,000.
Cornerstone 8-7 calculated cost of goods sold for the year at $10,708,000.
Cornerstone 8-8 calculated total marketing expense of $957,000.
Cornerstone 8-9 calculated total administrative expense of $212,000.
Income taxes are paid at the rate of 30 percent of operating income.

Why:

The budgeted income statement pulls the results of all the operating budgets together and helps managers determine what the company's performance will be by the end of the year. If the net income does not meet management's objectives, they must go back and find ways to increase sales and/or decrease expenses.

Required:

1. Construct a budgeted income statement for ABT Inc. for the coming year.
2. ***What if*** ABT's income tax rate increased to 40 percent? What effect would that have on operating income? On income before taxes? On net income?

Solution:

1.

ABT Inc.
Budgeted Income Statement
For the Year Ended December 31, 2013

Sales		$12,000,000
Less: Cost of goods sold		10,708,000
Gross margin		1,292,000
Less:		
Marketing expense	$957,000	
Administrative expense	212,000	1,169,000
Operating income		123,000
Less: Interest expense (see Cornerstone 8-12)		54,000
Income before income taxes		69,000
Less: Income taxes (0.30 × $69,000)		20,700
Net income		$ 48,300

2. If ABT's income tax rate rises to 40 percent, there will be no impact on operating income or income before taxes. However, income taxes will increase to $27,600, and net income will decrease to $41,400.

identical to that of the direct materials purchases budget in a manufacturing firm. The only other difference between the operating budgets of manufacturing and merchandising firms is the absence of direct materials purchases and direct labour budgets in a merchandising firm.

In a for-profit service firm, the sales budget is also the production budget. The sales budget identifies each service and the quantity of it that will be sold. Since there are no finished goods inventories, services produced will be identical to services sold.

For example, the **Toronto Raptors** basketball team budgets the number of seats it expects to fill at each game and the price per ticket. Other revenues (such as television royalties and concession sales) are also budgeted.

In a not-for-profit service firm, the sales budget is replaced by a budget that identifies the levels of the various services that will be offered for the coming year and the sources of funds to pay for producing those services. The source of the funds may be tax revenues, contributions, payments by users of the services, or some combination. For example, a local **United Way**'s board of directors will budget the campaign target (dollars of contributions) for the coming year and then distribute the total funds among the qualifying agencies according to three possible levels of contribution—pessimistic, expected, and optimistic.

Both for-profit and not-for-profit service organizations lack finished goods inventory budgets. However, all the remaining operating budgets found in a manufacturing organization have counterparts in service organizations. A not-for-profit service organization's income statement is replaced by a statement of sources and uses of funds.

We have seen how the firm developed a master budget and used it to plan for the coming year. Once the plan is developed, the budget can be used for control and decision making. For meaningful comparisons, however, it may be necessary to recalculate some measures of output. Flexible budgeting can be used to create plans for various levels of activity. Furthermore, the company that uses activity-based costing may find activity-based budgeting (ABB) to be more valuable than traditional budgeting. Activity-based budgets can be more accurate in planning and are more useful for control.

OBJECTIVE 3
Identify the components of the financial budget, and prepare a cash budget.

Preparing the Financial Budget

The remaining budgets found in the master budget are the financial budgets. Typical financial budgets include the budget for capital expenditures, the cash budget, the budgeted balance sheet, and the budgeted statement of cash flows.

While the master budget is a plan for one year, the **capital expenditures budget** is a financial plan outlining the expected acquisition of long-term assets and typically covers a number of years. Details on the budgeted statement of cash flows are appropriately reserved for another course. Accordingly, only the cash budget and the budgeted balance sheet will be illustrated here.

The Cash Budget

Understanding cash flow is critical to managing a business. Often, a business is successful in producing and selling a product but fails because of timing problems associated with cash inflows and outflows. By knowing when cash deficiencies and surpluses are likely to occur, a manager can plan to borrow cash when needed and to repay the loans during periods of excess cash. Bank loan officers use a company's cash budget to document the need for cash, as well as the company's ability to repay. Because cash flow is the lifeblood of an organization, the cash budget is one of the most important budgets in the master budget.

Components of the Cash Budget

The **cash budget** is the detailed plan that shows all expected sources and uses of cash. The cash budget, illustrated in Exhibit 8-4A, has the following five main sections:

1. Total cash available
2. Cash disbursements
3. Cash excess or deficiency
4. Financing
5. Cash balance

The *total cash available* section consists of the beginning cash balance and the expected cash receipts. Expected cash receipts include all sources of cash for the

Exhibit 8-4

Cash Budget and Balance Sheet

A. The Cash Budget

	Beginning cash balance
+	Cash receipts
	Cash available
−	Cash disbursements
−	Minimum cash balance
	Excess or deficiency of cash
−	Repayments
+	Loans
+	Minimum cash balance
	Ending cash balance

B. Balance Sheet for ABT Inc.

ABT Inc.
Balance Sheet
December 31, 2012

Assets		
Current assets:		
Cash	$ 120,000	
Accounts receivable	300,000	
Materials inventory	50,000	
Finished goods inventory	55,000	
Total current assets		$ 525,000
Property, plant, and equipment (PP&E):		
Land	2,500,000	
Buildings and equipment	9,000,000	
Accumulated depreciation	(4,500,000)	
Total PP&E		7,000,000
Total assets		$7,525,000
Liabilities and Shareholders' Equity		
Current liabilities:		
Accounts payable		$ 100,000
Shareholders' equity:		
Common stock	$ 600,000	
Retained earnings	6,825,000	
Total shareholders' equity		7,425,000
Total liabilities and shareholders' equity		$7,525,000

period being considered. One source of cash is cash sales. However, often a significant proportion of sales is on account; thus, a major task of an organization is to determine the pattern of collection for its accounts receivable.

If a company has been in business for a while, it can use past experience to create an accounts receivable aging schedule. In other words, the company can determine, on average, what percentages of its accounts receivable are paid in the months following the sales. Cornerstone 8-11 shows how and why to prepare a cash receipts budget, including an accounts receivable aging schedule.

The *cash disbursements* section lists all planned cash outlays for the period except for interest payments on short-term loans (these payments appear in the financing section). All expenses not resulting in a cash outlay are excluded from the list. (Depreciation, for example, is never included in the disbursements section.)

CORNERSTONE 8-11

The HOW and WHY of Constructing a Cash Receipts Budget with an Accounts Receivable Aging Schedule

Information:

Recall from Cornerstone 8-1 that in 2013 ABT sales are Quarter 1, $1,400,000; Quarter 2, $4,200,000; Quarter 3, $4,800,000; and Quarter 4, $1,600,000. In ABT's experience, 50 percent of sales are paid in cash. Of the sales on account, 70 percent are collected in the quarter of sale; the remaining 30 percent are collected in the quarter following the sale. Total sales for the fourth quarter of 2012 totalled $2,000,000.

Why:

The cash receipts budget shows sources of cash for the period. Some sales may be cash; some are on account and may be received later. The embedded accounts receivable aging schedule helps managers determine how much of a period's sales on account will actually be received in cash. Cash receipts are a critical part of the cash budget.

Required:

1. Calculate cash sales expected in each quarter of 2013.
2. Construct a cash receipts budget including an accounts receivable aging schedule for ABT Inc. for each quarter of the coming year.
3. ***What if*** ABT determined that the percentage received in the quarter after the quarter of sale was 25 percent and that the remaining 5 percent was never collected? How would that affect cash received in each quarter?

Solution:

1. Quarter 1, 2013, Cash sales $= 0.50 \times \$1{,}400{,}000 = \$700{,}000$
   Quarter 2, 2013, Cash sales $= 0.50 \times \$4{,}200{,}000 = \$2{,}100{,}000$
   Quarter 3, 2013, Cash sales $= 0.50 \times \$4{,}800{,}000 = \$2{,}400{,}000$
   Quarter 4, 2013, Cash sales $= 0.50 \times \$1{,}600{,}000 = \$800{,}000$

2.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cash sales	$ 700,000	$2,100,000	$2,400,000	$ 800,000
Received on account from:				
Quarter 4, 2012[a]	300,000			
Quarter 1, 2013[b]	490,000	210,000		
Quarter 2, 2013[c]		1,470,000	630,000	
Quarter 3, 2013[d]			1,680,000	720,000
Quarter 4, 2013[e]				560,000
Total cash receipts	$1,490,000	$3,780,000	$4,710,000	$2,080,000

[a] $1,000,000 × 0.30 = $300,000
[b] $700,000 × 0.70 = $490,000; $700,000 × 0.30 = $210,000
[c] $2,100,000 × 0.70 = $1,470,000; $2,100,000 × 0.30 = $630,000
[d] $2,400,000 × 0.70 = $1,680,000; $2,400,000 × 0.30 = $720,000
[e] $800,000 × 0.70 = $560,000

3. The 5 percent of accounts receivable that ABT never collects is bad debts expense. It never appears on the cash budget since it is never collected in cash. The cash received in the quarter after the quarter of sale would be reduced and total cash would be reduced. The following is the cash

CORNERSTONE 8-11 *(continued)*

receipts budget with the updated accounts receivable aging schedule using the new assumption.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Cash sales	$ 700,000	$2,100,000	$2,400,000	$ 800,000
Received on account from:				
Quarter 4, 2012	250,000			
Quarter 1, 2013	490,000	175,000		
Quarter 2, 2013		1,470,000	525,000	
Quarter 3, 2013			1,680,000	600,000
Quarter 4, 2013				560,000
Total cash receipts	$1,440,000	$3,745,000	$4,605,000	$1,960,000

The *cash excess or deficiency* section compares the cash available with the cash needed. Cash needed includes the total cash disbursements plus the minimum cash balance required by company policy. The minimum cash balance is simply the lowest amount of cash on hand that the firm finds acceptable. Consider your own chequing account. You probably try to keep at least some cash in the account, perhaps because a minimum balance avoids service charges or because it allows you to make an unplanned purchase. Similarly, companies also require minimum cash balances. The amount varies from firm to firm and is determined by each company's particular needs and policies. If the total cash available is less than the cash needs, a deficiency exists. In such a case, a short-term loan will be needed. On the other hand, with a cash excess (cash available is greater than the firm's cash needs), the firm can repay loans and perhaps make some temporary investments.

The *financing* section of the cash budget consists of borrowings and repayments. If there is a deficiency, the financing section shows the necessary amount to be borrowed. When excess cash is available, the financing section shows planned repayments, including interest.

The final section of the cash budget is the planned ending cash balance. Remember that the minimum cash balance was subtracted to find the cash excess or deficiency. However, the minimum cash balance is not a disbursement, so it must be added back to yield the planned ending balance.

Once all sections of the cash budget are understood, it is time to construct one. Cornerstone 8-12 shows how and why to prepare the cash budget.

The cash budget shown in Cornerstone 8-12 underscores the importance of breaking down the annual budget into smaller time periods. The cash budget for the year implies that there is enough cash from operations to buy the new equipment. Quarterly information, however, shows that short-term borrowing is needed to buy the new equipment earlier in the year rather than later. Breaking down the annual cash budget into quarterly or monthly time periods conveys more information. Most firms prepare monthly cash budgets; some even prepare weekly and daily cash budgets.

ABT's cash budget shows another important piece of information. By the end of the fourth quarter, the firm holds a considerable amount of cash ($488,300). ABT should consider investing this cash in an interest-earning account or short-term marketable securities rather than allow it to sit idly in a bank account. The management of ABT could also consider making additional long-term investments. Once plans are finalized for use of the excess cash, the cash budget should be revised to reflect those plans. Budgeting is a dynamic process. As the budget is developed, new information becomes available and is incorporated in the budgetary plans.

CORNERSTONE 8-12

The HOW and WHY of Constructing a Cash Budget

Information:

The information needed to prepare the cash budget comes from Cornerstones 8-1 through 8-11 and from the following information.

a. ABT requires a $100,000 minimum cash balance for the end of each quarter. On December 31, 2012, the cash balance was $120,000.
b. Money can be borrowed and repaid in multiples of $100,000. Interest is 12 percent per year. Interest payments are made only for the amount of the principal being repaid. All borrowing and repayment take place at the end of a quarter.
c. All materials are purchased on account; 80 percent of purchases are paid for in the quarter of purchase. The remaining 20 percent are paid in the following quarter. The purchases for the fourth quarter of 2012 were $500,000.
d. Budgeted depreciation is $200,000 per quarter for overhead; $5,000 for marketing expense; and $12,000 for administrative expense. (Remember that depreciation is not a cash expense and must be deleted from total expenses before the cash budget is prepared.)
e. The capital budget for 2013 revealed plans to purchase additional equipment for $600,000 in the first quarter. The acquisition will be financed with operating cash, supplementing it with short-term loans as necessary.
f. Corporate income taxes of $20,700 will be paid at the end of the fourth quarter.

Why:

The cash budget is critical to managers' planning. It shows how much cash will be available each time period. Companies without sufficient cash may go under even if their net income is positive.

Required:

1. Calculate cash payments for purchases expected in each quarter of 2013. (*Hint*: Use Cornerstone 8-3.)
2. Prepare a cash budget for ABT Inc. for each quarter of the coming year.
3. ***What if*** ABT did not have access to short-term financing? How would that affect the cash budget? ABT's ability to stay in business?

Solution:

1. $$\text{Payments in current quarter} = 0.8(\text{current quarter purchases}) + 0.2(\text{prior quarter purchases})$$

$$\text{Payments Quarter 1} = 0.8(\$654{,}000) + 0.2(\$500{,}000) = \$623{,}200$$

$$\text{Payments Quarter 2} = 0.8(\$1{,}560{,}000) + 0.2(\$654{,}000) = \$1{,}378{,}800$$

$$\text{Payments Quarter 3} = 0.8(\$1{,}426{,}000) + 0.2(\$1{,}560{,}000) = \$1{,}452{,}800$$

$$\text{Payments Quarter 4} = 0.8(\$520{,}000) + 0.2(\$1{,}426{,}000) = \$701{,}200$$

2.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Beginning balance (a)*	$ 120,000	$ 100,800	$ 123,000	$ 190,200	$ 120,000
Collections (C8-11):					
Cash sales	700,000	2,100,000	2,400,000	800,000	6,000,000
Received on account:					
Current quarter sales	490,000	1,470,000	1,680,000	560,000	4,200,000
Prior quarter sales	300,000	210,000	630,000	720,000	1,860,000
Total cash available	$1,610,000	$3,880,800	$4,833,000	$2,270,200	$12,180,000

CORNERSTONE 8-12 *(continued)*

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
Disbursements:					
Payments for purchases:					
Current quarter purchases	$ 523,200	$1,248,000	$1,140,800	$ 416,000	$ 3,328,000
Prior quarter purchases	100,000	130,800	312,000	285,200	828,000
Direct labour (C8-4)	504,000	1,260,000	1,176,000	420,000	3,360,000
Overhead (C8-5, d)	408,000	840,000	792,000	360,000	2,400,000
Marketing expense (C8-8, d)	133,000	338,000	333,000	133,000	937,000
Administrative expense (C8-9, d)	41,000	41,000	41,000	41,000	164,000
Income tax (f)				20,700	20,700
Equipment (e)	600,000				600,000
Total disbursements	2,309,200	3,857,800	3,794,800	1,675,900	11,637,700
Minimum cash balance (a)	100,000	100,000	100,000	100,000	100,000
Total cash needs	2,409,200	3,957,800	3,894,800	1,775,900	11,737,700
Excess (deficiency)	(799,200)	(77,000)	938,200	494,300	442,300
Financing (b):					
Borrowings	800,000	100,000			900,000
Repayments			800,000	(100,000)	(900,000)
Interest			(48,000)	(6,000)	(54,000)
Total financing	800,000	100,000	(848,000)	(106,000)	(54,000)
Add: Minimum cash balance	100,000	100,000	100,000	100,000	100,000
Ending cash balance	$ 100,800	$ 123,000	$ 190,200	$ 488,300	$ 488,300

*Parenthetical references refer to Cornerstones, for example, C8-11 is Cornerstone 8-11, or to the information stated above.

3. If ABT had no access to short-term financing, then the company would be in severe trouble by the end of Quarter 1. By the end of Quarter 1, ABT has a shortfall of $699,200. It will not be able to make the cash payments it plans to make and will very possibly be forced out of business. The seasonal nature of ABT's sales make it imperative for the company to use borrowed money early in the year and to make up for it later in the year.

Budgeted Balance Sheet

The budgeted balance sheet for the coming year develops from information contained in the balance sheet for the previous year and in the various budgets in the master budget. It represents the culmination of the financial events expected of the coming year and shows management where the company is expected to be at the end of the year. The balance sheet for the beginning of the year is given in Exhibit 8-4B. This balance sheet is necessary in preparing the end-of-the-year budgeted balance sheet that is shown in Exhibit 8-5.

As we have described the individual budgets that make up the master budget, the interdependencies of the component budgets have become apparent. You may want to refer back to Exhibit 8-2 to review these interrelationships.

Exhibit 8-5

Budgeted Balance Sheet for ABT Inc.

ABT Inc.
Budgeted Balance Sheet
December 31, 2013

Assets		
Current assets:		
Cash[a]	$ 488,300	
Accounts receivable[b]	240,000	
Materials inventory[c]	50,000	
Finished goods inventory[d]	67,000	
Total current assets		$ 845,300
Property, plant, and equipment (PP&E):		
Land[e]	$ 2,500,000	
Buildings and equipment[f]	9,600,000	
Accumulated depreciation[g]	(5,368,000)	
Total PP&E		6,732,000
Total assets		$7,577,300
Liabilities and Shareholders' Equity		
Current liabilities:		
Accounts payable[h]		$ 104,000
Shareholders' equity:		
Common stock[i]	$ 600,000	
Retained earnings[j]	6,873,300	
Total shareholders' equity		7,473,300
Total liabilities and shareholders' equity		$7,577,300

[a] Ending cash balance for the year from Cornerstone 8-12.
[b] From Cornerstone 8-1 and Cornerstone 8-11, fourth quarter credit sales times 0.3 (percentage to be collected in the following quarter).
[c] From Cornerstone 8-3, fourth quarter desired ending inventory of 5,000,000 kg times $0.01 (cost per kilogram).
[d] From Cornerstone 8-6.
[e] From Exhibit 8-4B, December 31, 2012, balance sheet, Land account.
[f] From Exhibit 8-4B, December 31, 2012, balance sheet, Buildings and Equipment account plus $600,000 for new equipment purchase.
[g] From Exhibit 8-4B, December 31, 2012, balance sheet, accumulated depreciation balance plus depreciation balances from Cornerstone 8-12 ($4,500,000 + $800,000 + $20,000 + $48,000).
[h] Equals 20 percent of fourth-quarter purchases of direct materials, see Cornerstones 8-3 and 8-12.
[i] From Exhibit 8-4B, December 31, 2012, balance sheet, Common Stock account.
[j] From Exhibit 8-4B, December 31, 2012, balance sheet, retained earnings balance plus net income from Cornerstone 8-10.

Shortcomings of the Traditional Master Budget Process

Shortcomings of the master budget can be classified into several categories. The traditional master budget is:

1. department oriented and does not recognize the interdependencies among departments.
2. static, not dynamic.
3. results, not process, oriented.

Let's look more closely at each of these.

Departmental Orientation In traditional budgeting, each department develops its own budget. These budgets are then aggregated to form the overall company budget. A department may start by determining what resources (i.e., labour, supplies, etc.) it currently has and then adjust those levels for the potential level of output. That is, in the traditional budget, departments plan from resources to outputs. The activity-based budgeting (ABB) approach is the opposite. ABB starts by asking what

level of output is desired and then works backward to see what resources are necessary to achieve that level of output. We might ask, what difference does it make? Couldn't you achieve the same effect whether you go backward or forward? The answer, rooted in human behaviour, is no. By concentrating on last year's costs and going forward, a department locks in past ways of doing things. Companies that use ABB, however, start first with the desired output and then figure out what resources are needed. That level of resources may or may not be the same as last year's level.

As a result, traditional budgeting may have managers feeling embattled. There is a sense of "every department for itself." Managers feel encouraged to use every cent of budgeted resources, whether or not those resources are needed. Indeed, if the department did not use the full level of budgeted resources, it would have a hard time making a case for increased—or even the same level of—resources in the coming year.

Static Rather than Dynamic Budgets A **static budget** is one developed for a single level of activity. Recall that the master budget is based on budgeted sales for the coming year. Once that amount is determined, production, marketing, and administrative budgets are built around it. An adjunct to the static nature of the budget is the use of last year's budget to create this year's budget. Often, the current budget is based on last year's amounts as adjusted for inflation. This approach to budgeting, called the **incremental approach**, can incorporate last year's inefficiencies into the current budget. Under the incremental approach, heads of budgeting units often strive to spend all of the year's budget so that no surplus exists at the end of the year. (This is particularly true for government agencies.) This action is taken to maintain the current level of the budget and enable the head of the unit to request additional funds.

For example, a military base was faced with the possibility of a surplus at the end of the fiscal year. The base commander, however, found ways to spend the extra money before the year ended. Officers and other personnel residing around the base were given several bags of lawn fertilizer. Also, new furniture was acquired for the officer quarters.

The waste and inefficiency portrayed in this example is often perpetuated and encouraged by incremental budgeting.

Zero-base budgeting is an alternative approach.[3] Unlike with incremental budgeting, the prior year's budgeted level is not taken for granted. Existing operations are analyzed, and continuance of the activity or operation must be justified on the basis of its need or usefulness to the organization. The burden of proof is on each manager to justify why any money should be spent at all. Zero-base budgeting requires extensive, in-depth analysis. Although this approach has been used successfully in industry and government, it is time consuming and costly. Advocates of the incremental approach argue that incremental budgeting also uses extensive, in-depth reviews but not as frequently because they are not justified on a cost-benefit basis. A reasonable compromise may be to use zero-base budgeting every three to five years in order to weed out waste and inefficiency. Especially in a period of intense competition and re-engineering, zero-base budgeting can force managers to "break set" and see their units in a different perspective.

Results Orientation This shortcoming is closely allied to the static nature of the master budget. By focusing on results instead of process, managers, in effect, disconnect the process from its output. When budgets are resource driven rather than output driven, then managers concentrate on resources and may fail to see the link between resources and output. Then, when the need for cost cutting arises, they make across-the-board cuts, slicing every department's budget by the same percentage. This has the superficial appearance of fairness—in that every department "shares the pain." Unfortunately, some departments have more fat than others, and some may be downright unneeded. Across-the-board cuts do not cut true waste and inefficiency; that is not their point.

[3] Zero-base budgeting was developed by Peter Pyhrr of Texas Instruments. For a detailed discussion of the approach, see Peter Pyhrr, *Zero-Base Budgeting* (New York: Wiley, 1973).

It is important to realize that the master budget is not inherently flawed. That is why the traditional approach to budgeting has been used for so long. In fact, it has been very useful over the decades and many managers strongly agree that "budgets are indispensable and companies couldn't manage without them."[4] However, the past 30 or so years have been characterized by rapid change. In a period of change, managers may not realize that previously acceptable ways of doing things no longer work. This is the case for the master budget. For example, consider its static nature. If sales are much the same from year to year, if the production process does not change, and if the firm's product mix is fairly simple and stable, then a static budget based in large part on last year's numbers makes sense. However, this is not the situation for the vast majority of businesses today. Flexible budgets can give managers some feel for the impact of fixed and variable costs. Activity-based budgets go further, by recognizing the numerous drivers for variable costs and by starting with outputs and working backwards to resources.

OBJECTIVE 4

Define flexible budgeting, and discuss its role in planning, control, and decision making.

Flexible Budgets versus Static Budgets

Budgets are useful control measures. To be used in performance evaluation, however, it is necessary to determine how budgeted amounts should be compared with actual results. Master budget amounts, while vital for planning, are less useful for control. The reason is that the anticipated level of activity rarely equals the actual level of activity. Therefore, the costs and revenues associated with the anticipated level of activity cannot be readily compared with actual costs and revenues for a different level of activity.

Static Budgets

Budgets that are developed around a single expected level of activity (expected sales for the year) are static budgets. Because the revenues and costs prepared for static budgets depend on a level of activity that rarely equals actual activity, they are not very useful when it comes to preparing performance reports.

To illustrate, let's return to the ABT Inc. example used in developing the master budget. Suppose that ABT provides quarterly performance reports. Recall that ABT anticipated sales of 2 million units in the first quarter and had budgeted production of 2.4 million units to support that level of sales (Cornerstone 8-2). Suppose instead that sales activity was greater than expected in the first quarter; 2.6 million concrete blocks were sold instead of the 2 million budgeted in the sales budget; and, because of increased sales activity, production was increased over the planned level. Instead of producing 2.4 million units, ABT produced 3 million units. A performance report comparing the actual production costs for the first quarter with the original planned production costs is given in Exhibit 8-6A.

According to the report, unfavourable variances occurred for direct materials, direct labour, supplies, indirect labour, and rent. However, something is fundamentally wrong with the report. Actual costs for production of *3 million concrete blocks* are being compared with planned costs for production of *2.4 million*. Because direct materials, direct labour, and variable overhead are variable costs, we expect them to be greater as more is produced. Thus, even if cost control were perfect for the production of 3 million units, unfavourable variances would be shown for all variable costs.

To create a meaningful performance report, actual costs and expected costs must be compared at the *same* level of activity. Since actual output often differs from planned output, some method is needed to compute what the costs should have been for the actual output level.

Flexible Budgets

The budget that provides expected costs for a variety of activity levels is called a **flexible budget**. Flexible budgeting can be used in planning by showing what costs will be at various levels of activity. When used this way,

[4] This quote is taken from an article discussing the results of a survey of IMA members on budgeting. Theresa Libby and R. Murray Lindsay, "Beyond Budgeting or Better Budgeting? IMA Members Express Their Views," *Strategic Finance* (August 2007): 46–51. (Quote taken from pp. 48–49.)

Exhibit 8-6

Performance Reports

A. ABT Performance Report for Quarter 1: Comparison of Actual with Static (Master) Budget Amounts

	Actual	Budgeted	Variance	
Units produced	3,000,000	2,400,000	600,000	F[a]
Direct materials cost	$ 927,300	$ 624,000[b]	$303,300	U[c]
Direct labour cost	630,000	504,000[d]	126,000	U
Overhead:[e]				
Variable:				
Supplies	80,000	72,000	8,000	U
Indirect labour	220,000	168,000	52,000	U
Power	40,000	48,000	(8,000)	F
Fixed:				
Supervision	90,000	100,000	(10,000)	F
Depreciation	200,000	200,000	0	
Rent	30,000	20,000	10,000	U
Total	$2,217,300	$1,736,000	$481,300	U

[a] F means the variance is favourable.
[b] 2,400,000 units × $0.26 (Cornerstone 8-6 gives unit costs for direct materials and direct labour).
[c] U means the variance is unfavourable.
[d] 2,400,000 units × $0.21 (Cornerstone 8-6 gives unit costs for direct materials and direct labour).
[e] Variable overhead equals 2,400,000 units times: $0.03 for supplies; $0.07 for indirect labour; and $0.02 for power. Budgeted fixed overhead per quarter is given in Cornerstone 8-5.

B. Managerial Performance Report: Quarterly Production (in thousands)

	Actual Results (1)	Flexible Budget (2)	Flexible Budget Variances (3) = (1) − (2)	Static Budget (4)	Volume Variances (5) = (2) − (4)
Units produced	3,000,000	3,000,000	0	2,400,000	600,000 F
Direct materials cost	$ 927,300	$ 780,000	$147,300 U	$ 624,000	$156,000 U
Direct labour cost	630,000	630,000	0	504,000	126,000 U
Overhead:					
Variable:					
Supplies	80,000	90,000	(10,000) F	72,000	18,000 U
Indirect labour	220,000	210,000	10,000 U	168,000	42,000 U
Power	40,000	60,000	(20,000) F	48,000	12,000 U
Fixed:					
Supervision	90,000	100,000	(10,000) F	100,000	0
Depreciation	200,000	200,000	0	200,000	0
Rent	30,000	20,000	10,000 U	20,000	0
Total	$2,217,300	$2,090,000	$127,300 U	$1,736,000	$354,000 U

managers can deal with uncertainty by examining the expected financial results for a number of plausible scenarios. Spreadsheets are particularly useful in developing this type of flexible budget.

The budget that provides budgeted costs for the actual level of activity is also a flexible budget. The flexible budget can be used after the fact, for control purposes to compute what costs should have been for the actual level of activity. Once expected costs are known for the actual level of activity, a performance report that compares those expected costs to actual costs can be prepared. When used for control, flexible budgets help managers compare "apples to apples" in assessing performance. Cornerstone 8-13 shows how and why to prepare a flexible budget for varying levels of activity.

CORNERSTONE 8-13

The HOW and WHY of Constructing a Flexible Budget for Varying Levels of Activity

Information:

ABT Inc. has the following budgeted variable costs per unit produced:

Direct materials	$0.26
Direct labour	0.21
Variable overhead:	
Supplies	0.03
Indirect labour	0.07
Power	0.02

Budgeted fixed overhead costs per quarter include supervision of $100,000, depreciation of $200,000, and rent of $20,000.

Why:

A flexible budget allows managers to see what impact changes in activity level will have on total costs. When the budget includes fixed costs, increases in activity level lead to increases in total cost, but less than proportionately.

Required:

1. Prepare a flexible budget for all costs of production for the following levels of production: 2,400,000 units, 3,000,000 units, and 3,600,000 units.
2. What is the per-unit total product cost for each of the production levels from Requirement 1?
3. ***What if*** ABT found that indirect labour was really fixed at $210,000 per quarter? How would that affect the unit product costs calculated in Requirement 2?

Solution:

1.

	Variable Cost per Unit	Range of Production in Units		
		2,400,000	3,000,000	3,600,000
Production costs:				
Variable:				
Direct materials	$0.26	$ 624,000	$ 780,000	$ 936,000
Direct labour	0.21	504,000	630,000	756,000
Variable overhead:				
Supplies	0.03	72,000	90,000	108,000
Indirect labour	0.07	168,000	210,000	252,000
Power	0.02	48,000	60,000	72,000
Total variable costs	$0.59	1,416,000	1,770,000	2,124,000
Fixed overhead:				
Supervision		100,000	100,000	100,000
Depreciation		200,000	200,000	200,000
Rent		20,000	20,000	20,000
Total fixed costs		320,000	320,000	320,000
Total production costs		$1,736,000	$2,090,000	$2,444,000

CORNERSTONE 8-13 *(continued)*

2. Per-unit product cost @ 2,400,000 units = \$1,736,000/2,400,000
   = \$0.72 (rounded)
   Per-unit product cost @ 3,000,000 units = \$2,090,000/3,000,000
   = \$0.70 (rounded)
   Per-unit product cost @ 3,600,000 units = \$2,444,000/3,600,000
   = \$0.68 (rounded)

3. If indirect labour was fixed at \$210,000 per quarter, there would be no difference in the total or per-unit cost for 3,000,000 units produced. However, at 2,400,000 units produced, the indirect labour cost would be higher than it currently is, and therefore the total product cost and per-unit cost would be higher. At 3,600,000 units produced, the indirect labour cost would be lower than it currently is, and therefore the total product cost and per-unit cost would be lower.

Notice in Cornerstone 8-13 that total budgeted production costs increase as the activity level increases. Budgeted costs change because of variable costs. Because of this, a flexible budget is sometimes referred to as a **variable budget**. Cornerstone 8-13 reveals what the costs should have been for the actual level of activity (3 million blocks). A revised performance report that compares actual and budgeted costs for the actual level of activity is illustrated in Cornerstone 8-14.

The revised performance report in Cornerstone 8-14 paints a much different picture than the one in Exhibit 8-6A. By comparing budgeted costs for the actual level of activity with actual costs for the same level, **flexible budget variances** are generated. Managers can locate possible problem areas by examining these variances. According to the ABT flexible budget variances, expenditures for direct materials are excessive. (The other unfavourable variances seem relatively small.) With this knowledge, management can search for the causes of the excess expenditures and prevent the same problems from occurring in the future.

Budgets can be used to examine the efficiency and effectiveness of a company. **Efficiency** is achieved when the business process is performed in the best possible way, with little or no waste. The flexible budget provides an assessment of the efficiency of a manager. This is so because the flexible budget compares the actual costs for a given level of output with the budgeted costs for the same level. **Effectiveness** means that a manager achieves or exceeds the goals described by the static budget. Thus, efficiency examines how well the work is done, and effectiveness examines whether or not the right work is being accomplished. Any differences between the flexible budget and the static budget are attributable to differences in volume. They are called *volume variances*. A five-column performance report that reveals both the flexible budget variances and the volume variances can be used. Exhibit 8-6B provides an example of this report using the ABT data.

As the report in Exhibit 8-6B reveals, production volume was 600,000 units greater than the original budgeted amount. Thus, the manager exceeded the output goal. This volume variance is labelled *favourable* because it exceeds the original production goal. (Recall that the *reason* for the extra production was because the demand for the product was greater than expected. Thus, the increase in production over the original amount was truly favourable.) On the other hand, the budgeted variable costs are greater than expected because of the increased production. This difference is labelled unfavourable because the costs are greater than expected; however, the increase in costs is because of an increase in production. Thus, it is totally reasonable. For this particular example, the effectiveness of the manager is not in question; thus, the main issue is how well the manager controlled costs as revealed by the flexible budget variances.

CORNERSTONE 8-14

The HOW and WHY of Constructing a Flexible Budget for the Actual Level of Activity

Information:

ABT Inc. produced 3,000,000 units and has the following actual costs in the first quarter:

Direct materials	$927,300
Direct labour	630,000
Supplies	80,000
Indirect labour	220,000
Power	40,000
Supervision	90,000
Depreciation	200,000
Rent	30,000

Refer to Cornerstone 8-13 for budgeted overhead costs per quarter for production of 3,000,000 units.

Why:

A flexible budget allows managers to see what impact a change in activity level will have on total costs. When the flexible budget is used for control, budgeted costs for the actual activity experienced can be compared with actual costs to get a meaningful idea of whether or not costs were as expected.

Required:

1. Prepare a performance report for actual costs for the first quarter, comparing them with the flexible budget amounts for the actual level of production found in Cornerstone 8-13.
2. What is the actual per-unit cost? What is the flexible budgeted per-unit product cost?
3. ***What if*** ABT had the same actual costs but had only produced 2,900,000 units? Would the total variance be more or less unfavourable than it is in Requirement 1?

Solution:

1.

	Actual	Budgeted	Variance
Units produced	3,000,000	3,000,000	0
Direct materials cost	$ 927,300	$ 780,000	$147,300 U
Direct labour cost	630,000	630,000	0
Overhead:			
Variable:			
Supplies	80,000	90,000	(10,000) F
Indirect labour	220,000	210,000	10,000 U
Power	40,000	60,000	(20,000) F
Fixed:			
Supervision	90,000	100,000	(10,000) F
Depreciation	200,000	200,000	0
Rent	30,000	20,000	10,000 U
Total	$2,217,300	$2,090,000	$127,300 U

2. Actual per-unit cost = \$2,217,300/3,000,000 = \$0.7391
Budgeted per-unit cost = \$2,090,000/3,000,000 = \$0.6967

3. If only 2,900,000 units had been produced, the flexible budget amounts for variable overhead would have been smaller and every variable overhead variance would have been more unfavourable (or less favourable). The total variance would have been more unfavourable.

CORNERSTONE 8-14 *(continued)*

Activity-Based Budgets

OBJECTIVE 5
Define activity-based budgeting, and discuss its role in planning, control, and decision making.

We can look at a department's budget from three perspectives: a traditional approach, a flexible budgeting approach, and an activity-based approach. Traditional budgeting relies on the use of line items, such as salaries, supplies, depreciation on equipment, and so on. The flexible budget uses knowledge of cost behaviour to split the line items into fixed and variable components. The activity-based budget works backward from activities and their drivers to the underlying costs.

Flexible budgeting may also be accomplished using data from an activity-based costing system. In this case, a variety of drivers would be used rather than the single unit-based driver in the previous example. We can think of flexible budgeting using ABC costs and drivers as a simplified sort of activity-based budgeting. The ABC flexible budget is a more accurate tool for planning and does give an indication of more costly versus less costly activities. Thus, an ABC flexible budget can support continuous improvement and process management.

The ABT situation is tailor made for flexible budgeting. The output is homogeneous, and the production process is fairly simple. Basing variable costs on a volume-based driver works well. However, many firms have found that product diversity means that the richer set of drivers of activity-based costing are necessary to describe their cost structure. These firms will find that activity-based budgeting is more useful for their needs.[5]

The activity-based budget begins with output and then determines the resources necessary to create that output. Ideally, the organization translates its vision into a strategy with definable objectives in order to create value. Ways of creating value include growing market share, improving sales rates, reducing expenses, increasing profit margins, increasing productivity, and reducing the cost of capital. We can see how clearly ABB is related to performance evaluation and, in particular, to economic value added (as discussed in Chapter 10).

We can use the new Secure-Care Department of a large regional public accounting firm to illustrate the differences among traditional, flexible, and activity-based budgeting. First, let's review the history of the Secure-Care Department. A couple of years ago, Brad Covington, one of the firm's younger partners, persuaded his other partners to put an eldercare program into effect. Eldercare is a multifaceted program of personal financial and assurance services. The typical client is the elderly parent(s) of a grown child who lives outside the parents' city. The parents may need help paying monthly bills, balancing their chequing account, and finding and paying for in-home health and personal care. Brad felt that there was a need for eldercare services in the metropolitan area and that his accounting firm was ideally suited to provide these services. Not only were the financial services a natural for a public accounting firm, but the high confidence the public placed in accountants made it likely that clients would feel comfortable relying on their expertise in finding appropriate caretakers. The main problem, in Brad's mind, was the term

[5] Much of this section relies on ideas expressed in James A. Brimson and John Antos, *Driving Value Using Activity-Based Budgeting* (New York, NY: John Wiley & Sons, 1999). This book is a thorough approach to the subject.

"eldercare." After some discussion among firm members, the name Secure-Care was settled on.

During the first two years of operations, Brad developed a client base of 60. A variety of services were offered. For all clients, all business mail was rerouted to the accounting firm. The clients' chequing, savings, and money market accounts were kept up to date and reconciled each month by the firm. All bills were paid from the appropriate accounts. In addition, personal and household services were contracted out. The Secure-Care Department advertised for, interviewed, and investigated the backgrounds of all individuals hired to provide personal and household services to clients. Monthly personal visits were made to each client to ensure that their needs were being met. Finally, a monthly report on the financial and personal status of each client was prepared and delivered to the clients and any concerned adult children.

The Secure-Care Department consisted of a receptionist, two administrative assistants, and Brad—the managing partner for the department. Because there was insufficient room in the main offices of the accounting firm, Brad rented office space across the street. All investigative services (for background checks) were contracted out to a local private investigator with extensive experience in this area.

Exhibit 8-7A depicts the traditional budget for the coming year for the Secure-Care Department. Notice that the expense categories are listed along with a dollar amount for each one. How would a typical company using functional budgeting arrive at these figures? It would be a safe bet to assume that they would be based to a large extent on the level of those same expenses for the previous year. Maybe there would be some adjustment of certain figures (e.g., if salaries were expected to rise by 3 percent due to anticipated raises).

Suppose that Brad thinks the costs of the Secure-Care Department vary according to the number of clients. Cost behaviour concepts can be used to break the expense categories into fixed and variable components. Assume that supplies are strictly variable, at $166.67 per client. Telephone is a mixed cost, with a fixed component of $1,200 and a variable rate of $60 per client. The remaining expenses appear to be predominantly fixed. Then, a flexible budget for the following year's 60 estimated clients would appear as the one shown in Exhibit 8-7B. Notice that the total amount is still $273,800. The flexible budget shown here does not look like a great step forward. Its power lies in its ability to show changes in total cost as activity level changes. For example, the budget could be extended to show total costs at 50 and 70 clients as well. The key requirement is that the product is much the same from client to client. In the case of the Secure-Care Department, that would mean the needs of each client are very similar.

Brad was not satisfied with the results of the flexible budget. He knew that many of the expense categories were variable but that they did not necessarily vary with the number of clients. For example, one important and time-consuming activity was paying monthly bills, but the number of bills varied greatly from client to client. Similarly, some clients had just a couple of chequing and savings accounts while others had five or six chequing, money market, and savings accounts. Each of these had to be monitored and reconciled at the end of the month. In summary, there was considerable diversity among the clients. Therefore, Brad decided to build an activity-based budget.

To build an activity-based budget for the Secure-Care Department, four steps are needed: (1) the output of the department must be determined; (2) the activities needed to deliver the output, along with their related drivers, must be identified; (3) the demand for each activity must be estimated; and (4) the cost of resources required to produce the relevant activities must be determined. It is critically important to see that ABB is based on expected output. The traditional budget often plans forward from last year's experience, while the ABB plans backward from next year's output. The differences between the two approaches are more than semantic. While it may appear that the same results would hold in both cases, in practice, that is not so. In addition, the ABB approach, using resources and activities to create output, gives the manager much more information as well as ability to consider eliminating non-value-added activities.

Exhibit 8-7

Traditional, Flexible, and Activity-Based Budgets

A. Traditional Budget for the Secure-Care Department

Expense Category		Budgeted Amounts
Salaries and benefits:		
Brad	$110,000	
Administrative assistants	70,000	
Receptionist	30,000	$210,000
Rent		36,000
Supplies		10,000
PCs and Internet		4,000
Travel		3,000
Investigative services		6,000
Telephone		4,800
Total		$273,800

B. Flexible Budget for the Secure-Care Department

Expense Category		Budgeted Amounts for 60 Clients
Variable expenses:		
Supplies	$ 10,000	
Telephone	3,600	
Total variable expenses		$ 13,600
Fixed expenses:		
Salaries and benefits	210,000	
Rent	36,000	
PCs and Internet	4,000	
Travel	3,000	
Investigative services	6,000	
Telephone	1,200	
Total fixed expenses		260,200
Total expenses		$273,800

C. Activity-Based Budget for the Secure-Care Department

Activity Description	Activity Driver	Cost per Unit of Driver	Amount of Driver	Activity Cost
Processing mail	Number of clients	$125.00	60	$ 7,500
Paying bills	Number of bills	1.75	12,000	21,000
Reconciling accounts	Number of accounts	114.00	350	39,900
Advertising/interviewing	Number of new hires	120.00	60	7,200
Investigating	Number of new hires	100.00	60	6,000
Visiting homes	Number of clients	650.00	60	39,000
Writing reports	Number of clients	175.00	60	10,500
Managing department				142,700
Total				$273,800

The following information about the Secure-Care Department was developed:

- All clients received varying levels of the department's activities.
- The first activity is "processing mail." Brad decided that number of clients was a reasonable driver for this activity. All clients had mail, and the amount varied from

week to week. The receptionist opened all the mail and sorted it into folders by client. It took approximately two hours a day to perform this task.

- The second activity is "paying bills." There were approximately 1,000 bills per month, or 12,000 per year. The number of bills varied widely from client to client. The administrative assistants performed this activity, using computer software to enter and pay bills. Based on the amount of time this took and the cost of supplies, software, and postage, the average cost of paying one bill was $1.75.
- The third activity is "reconciling accounts." The administrative assistants performed this activity, and it took about 30 minutes per account each month. There were 350 accounts. This averaged out to one administrative assistant working full time on reconciling accounts. Related supplies and the use of a computer and software added another $4,900 to the total.
- The firm advertised for and interviewed caregivers for their clients as needed. The driver for this activity is number of new hires. The yearly cost, including newspaper advertising and the time of the administrative assistants, totalled $7,200 per year. On average, there were estimated to be 60 new hires in a year.
- A private investigator was retained to perform thorough background checks of prospective caregivers. Each background check cost $25, and an average of four prospective caregivers were checked for every successful new hire.
- Every month, the administrative assistants made personal visits to each client. The number of clients was a good driver for this activity, and the total cost was about $650 per client, per year.
- Each month, Brad or one of the administrative assistants prepared a monthly report for every client. The report detailed the financial activity and included the notes taken from the home visits. Prospective issues and problems were raised. These reports were sent to the clients as well as to interested adult children. The cost of time, supplies, and postage averaged $175 per client, per year.
- The final activity is managing the department and signing up new clients. Brad is responsible for the bulk of this activity. The activity does not have a driver, but instead, consists of the remaining costs of the department.

The Secure-Care Department's activity-based budget is shown in Exhibit 8-7C. Notice that the department has identified eight activities and four drivers. This level of detail is much richer than that for the flexible budget presented in Exhibit 8-7B, where there was only one driver, the number of clients. With an activity-based budget, we get a feel for the diversity among the clients. Some have more accounts, and some more bills to pay. In other words, "clients" are not all the same. There is considerable product diversity, and this diversity is not captured in either the traditional or the simple flexible budget.

The traditional, flexible, and activity-based budgets for the Secure-Care Department all total $273,800. But notice the richness of detail in the activity-based budget. Here we can see the relationship between output and resource usage. Also, the manager's attention is focused on the most costly activities: paying bills, reconciling accounts, and visiting homes. Brad may want to use this information in pricing the various parts of the secure-care service.

Earlier, we noted that both the traditional and flexible budgeting approaches worked well for particular sets of circumstances. Recall that a key feature is that the environment of the company remains stable. When that is the case, one year is much like the next. The technology is the same, and there is little product diversity. A single volume-based driver works well to account for any changes. However, many companies now face an environment that is changing rapidly in many ways. These companies are ill served by budgets that are founded on the notion that everything remains the same. Companies in a changing environment, whether it relates to changing technology, competition, or customer base, need a much more flexible technique for planning and control. The activity-based budget can be extended to include feature costing. This provides an even more powerful tool for planning and control.

Feature costing assigns costs to activities and products or services based on the product's or service's features.[6] In the Secure-Care Department, we could see that one client was not necessarily the same as another. In other words, different clients had different features that required the department to use different sets of activities to handle them. A client with only one chequing account and a few repetitive bills took little time. Other clients had numerous accounts and bills. Some clients may be difficult to get along with, leading to rapid turnover of their caregivers and necessitating additional interviewing and background investigation. If the company wanted to extend the ABB process, it could add feature costing. That is, it could determine what features of clients differentiate them into groups that require different sets of activities. We can easily imagine that the company might delve further into the various features, asking what leads to the different features (root cause analysis) and what could be done to modify the more costly features. For example, perhaps the monthly reports could be posted, using appropriate security, on the Internet. The reports could be updated relatively easily, and postage and printing costs could be minimized.

The Behavioural Dimension of Budgeting

OBJECTIVE 6
Identify and discuss the key features that a budgetary system should have to encourage managers to engage in goal-congruent behaviour.

Budgets are often used to judge the actual performance of managers. Bonuses, salary increases, and promotions are all affected by a manager's ability to achieve or beat budgeted goals. Since a manager's financial status and career can be affected, budgets can have significant behavioural effects. Whether those effects are positive or negative depends to a large extent on how budgets are used.

Positive behaviour occurs when the goals of individual managers are aligned with the goals of the organization and the manager has the drive to achieve them. The alignment of managerial and organizational goals is often referred to as **goal congruence**. In addition to goal congruence, however, a manager must also exert effort to achieve the goals of the organization.

If the budget is improperly administered, the reaction of subordinate managers may be negative. This negative behaviour can be manifested in numerous ways, but the overall effect is subversion of the organization's goals. **Dysfunctional behaviour** involves individual behaviour that is in basic conflict with the goals of the organization.

ETHICS A theme underlying the behavioural dimension of budgeting is ethics. The importance of budgets in performance evaluation and managers' pay raises and promotions leads to the possibility of unethical action. All of the dysfunctional actions regarding budgets that a manager may choose to take can have an unethical aspect. For example, a manager who deliberately underestimates sales and overestimates costs for the purpose of making the budget easier to achieve is engaging in unethical behaviour. It is the responsibility of the company to create budgetary incentives that do not encourage unethical behaviour. It is the responsibility of the manager to avoid engaging in such behaviour.◆

Characteristics of a Good Budgetary System

An ideal budgetary system is one that achieves complete goal congruence and simultaneously creates a drive in managers to achieve the organization's goals in an ethical manner. While an ideal budgetary system probably does not exist, research and practice have identified some key features that promote a reasonable degree of positive behaviour. These features include the following:

- frequent feedback on performance,
- monetary and nonmonetary incentives,
- participation,
- realistic standards,
- controllability of costs, and
- multiple measures of performance.

[6] J. A. Brimson, "Feature Costing: Beyond ABC," *Journal of Cost Management* (January/February 1998): 6–12.

Frequent Feedback on Performance Managers need to know how they are doing as the year unfolds. Providing them with frequent, timely performance reports allows them to know how successful their efforts have been and gives managers time to take corrective actions and change plans as necessary. Frequent performance reports can reinforce positive behaviour and give managers the time and opportunity to adapt to changing conditions. Continuous monitoring to see if actual costs and revenues are in accord with budgeted amounts and selective investigation of significant variances allows managers to focus only on areas that need attention. This process is called *management by exception*.

Monetary and Nonmonetary Incentives A sound budgetary system encourages goal-congruent behaviour. **Incentives** are the means that are used to encourage managers to work toward achieving the organization's goals. Incentives can be either negative or positive. Negative incentives use fear of punishment to motivate; positive incentives use rewards. What incentives should be tied to an organization's budgetary system?

The most successful companies view people as their most important asset. Their budgets reflect their underlying philosophy by including significant expenditures on recruiting and career development in good times. Even in difficult economic times, employees are protected to the extent possible.

For example, in 2008–2009, **FedEx** worked to keep costs under control and help save jobs. Pay was cut 5 percent across the board, and the CEO took a 20 percent pay cut. Similarly, **General Electric** CEO Jeff Immelt took a 28 percent pay cut and asked for no bonus for 2008.[7]

Of course, negative incentives can be used as well. The most serious negative incentive is the threat of dismissal. Other negative incentives include loss of bonuses, promotions, or raises.

Participative Budgeting Rather than imposing budgets on subordinate managers, **participative budgeting** allows subordinate managers considerable say in how the budgets are established. Typically, overall objectives are communicated to the manager, who helps develop a budget that will accomplish these objectives. In participative budgeting, the emphasis is on the accomplishment of the broad objectives, not on individual budget items.

The budget process described earlier for ABT uses participative budgeting. The company provides the sales forecast to its profit centres and requests a budget that shows planned expenditures and expected profits given that specific level of sales. The managers of the profit centres are fully responsible for preparing the budgets by which they will later be evaluated. Although the budgets must be approved by the president, disapproval is uncommon; the budgets are usually in line with the sales forecast and last year's operating results adjusted for expected changes in revenues and costs.

Participative budgeting communicates a sense of responsibility to subordinate managers and fosters creativity. Since the subordinate manager creates the budget, it is more likely that the budget's goals will become the manager's personal goals, resulting in greater goal congruence. Advocates of participative budgeting claim that the increased responsibility and challenge inherent in the process provide nonmonetary incentives that lead to a higher level of performance. They argue that individuals involved in setting their own standards will work harder to achieve them. In addition to the behavioural benefits, participative budgeting has the advantage of involving individuals whose knowledge of local conditions may enhance the entire planning process.

[7] "World's Most Admired Companies 2009," *Fortune* (March 16, 2009), http://money.cnn.com/magazines/fortune/mostadmired/2009/index.html.

Participative budgeting has three potential problems that should be mentioned:

1. Setting standards that are either too high or too low
2. Building slack into the budget (often referred to as *padding the budget*)
3. Pseudoparticipation

Some managers may tend to set the budget either too loose or too tight. Since budgeted goals tend to become the manager's goals when participation is allowed, making this mistake in setting the budget can result in decreased performance levels. If goals are too easily achieved, a manager may lose interest, and performance may actually drop. Challenge is important to aggressive and creative individuals. Similarly, setting the budget too tight ensures failure to achieve the standards and frustrates the manager. This frustration, too, can lead to poor performance. The trick is to get managers in a participative organization to set high but achievable goals.

The second problem with participative budgeting is the opportunity for managers to build slack into the budget. **Budgetary slack** exists when a manager deliberately underestimates revenues or overestimates costs. Either approach increases the likelihood that the manager will achieve the budget and consequently reduces the risk that the manager faces. Padding the budget also unnecessarily ties up resources that might be used more productively elsewhere.

Slack in budgets can be virtually eliminated if top management dictates lower expense budgets. However, the benefits to be gained from participation may far exceed the costs associated with padding the budget. Even so, top management should carefully review budgets proposed by subordinate managers and provide input, where needed, in order to decrease the effects of building slack into the budget.

The third problem with participation occurs when top management assumes total control of the budgeting process, seeking only superficial participation from lower-level managers. This practice is termed **pseudoparticipation**. Top management is simply obtaining formal acceptance of the budget from subordinate managers, not seeking real input. Accordingly, none of the behavioural benefits of participation will be realized.

Realistic Standards Budgeted objectives are used to gauge performance; accordingly, they should be based on realistic conditions and expectations. Budgets should reflect operating realities such as actual levels of activity, seasonal variations, efficiencies, and general economic trends. Flexible budgets, for example, are used to ensure that the budgeted costs provide standards that are compatible with the actual activity level. Another factor to consider is that of seasonality. Some businesses receive revenues and incur costs uniformly throughout the year; thus, spreading the annual revenues and costs evenly over quarters and months is reasonable for interim performance reports. However, for businesses with seasonal variations, this practice would result in distorted performance reports.

Factors such as efficiency and general economic conditions are also important. Occasionally, top management makes arbitrary cuts in prior-year budgets with the belief that the cuts will reduce fat or inefficiencies that allegedly exist. In reality, some units may be operating efficiently and others inefficiently. An across-the-board cut without any formal evaluation may impair the ability of some units to carry out their missions. General economic conditions also need to be considered. Budgeting for a significant increase in sales when a recession is projected is not only foolish but also potentially harmful.

For example, for years, **Kodak** confidently predicted that its film business would grow by 8 percent, when the industry was growing by only 4 percent.[8] The predicted growth did not occur. This type of unfounded optimism did nothing to improve sales and only hurt stock analysts' perception of the company.

[8] Peter Nulty, "Digital Imaging Had Better Boom Before Kodak Film Busts," *Fortune* (May 1, 1995): 80–83.

Controllability of Costs Conventional thought maintains that managers should be held accountable only for costs over which they have control. **Controllable costs** are costs whose level a manager can influence. In this view, a manager who has no responsibility for a cost should not be held accountable for it. For example, divisional managers have no power to authorize such corporate-level costs as research and development and salaries of top managers. Therefore, they should not be held accountable for the incurrence of those costs.

Many firms, however, do put noncontrollable costs in the budgets of subordinate managers. Making managers aware of the need to cover all costs is one rationale for this practice. If noncontrollable costs are included in a budget, they should be separated from controllable costs and labelled as *noncontrollable*.

Multiple Measures of Performance Often, organizations make the mistake of using budgets as their only measure of managerial performance. Overemphasis on this measure can lead to a form of dysfunctional behaviour called *milking the firm* or *myopia*. **Myopic behaviour** occurs when a manager takes actions that improve budgetary performance in the short run but bring long-run harm to the firm.

There are numerous examples of myopic behaviour. To meet budgeted cost objectives or profits, managers can reduce expenditures for preventive maintenance, advertising, and new product development. Managers can also fail to promote deserving employees to keep the cost of labour low and can choose to use lower-quality materials to reduce the cost of materials. In the short run, these actions will lead to improved budgetary performance, but in the long run, productivity will fall, market share will decline, and capable employees will leave for more attractive opportunities.

Managers who engage in this kind of behaviour often have a short tenure. That is, they spend three to five years before being promoted or moving to a new area of responsibility. Their successors are the ones who pay the price for their myopic behaviour. The best way to prevent myopic behaviour is to measure the performance of managers on several dimensions, including some long-run attributes. Productivity, quality, and personnel development are examples of other areas of performance that could be evaluated. Financial measures of performance are important, but overemphasis on them can be counterproductive.

Summary of Learning Objectives

1. Define budgeting, and discuss its role in planning, controlling, and decision making.

- A budget is a financial plan for the future.
- Budgeting is important for planning, control, and decision making.
- The master budget is the comprehensive plan for the coming year. It consists of:
  - The operating budget
  - The financial budget

2. Prepare the operating budget, identify its major components, and explain the interrelationships of the various components.

- The sales budget shows the expected sales quantity and price of each product or service.
- The production budget shows the budgeted units to be produced in each period to meet sales and desired ending inventory needs. It includes:
  - The direct materials purchases budget
  - The direct labour budget
  - The overhead budget

- Ending finished goods inventory and cost of goods sold budgets are used in the budgeted income statement.
- Operating expense budgets include:
  - The marketing expense budget
  - The administrative expense budget
  - Any other needed budgets for operating departments (e.g., Research and Development)
- The budgeted income statement is the culmination of the operating budget.

3. Identify the components of the financial budget, and prepare a cash budget.

- The cash budget shows the sources and disbursements of cash by period for the coming year.
  - Only cash items are shown in the cash budget.
  - The accounts receivable aging schedule helps companies determine the timing of cash receipts.
- The cash budget is critically important to the ability of a company to meet its obligations.
- The budgeted balance sheet shows the expected assets, liabilities, and owners' equity for the end of the coming year.

4. Define flexible budgeting, and discuss its role in planning, control, and decision making.

- A flexible budget shows costs for varying levels of activity.
  - Useful for planning
  - Useful for sensitivity analysis
- A flexible budget can be constructed for the actual level of activity.
  - Useful for control
  - Compares actual costs to budgeted amounts for actual level of activity

5. Define activity-based budgeting, and discuss its role in planning, control, and decision making.

- Activity-based budgeting recognizes interdependencies among departments.
- It also focuses on business processes.

6. Identify and discuss the key features that a budgetary system should have to encourage managers to engage in goal-congruent behaviour.

- Dysfunctional behaviour can occur when budgets are overemphasized as a control mechanism.
- Budgets are better performance measures when used with:
  - Participative budgeting
  - Other nonmonetary incentives
  - Frequent feedback on performance
  - Ensuring that the budgetary objectives reflect reality
  - Holding managers accountable for only controllable costs

CORNERSTONES FOR CHAPTER 8

Review Problems

I. Sales, Production, Direct Materials, and Direct Labour Budgets

Young Products produces coat racks. The projected sales for the first quarter of the coming year and the beginning and ending inventory data are as follows:

Sales	100,000 units
Unit price	$15
Beginning inventory	8,000 units
Targeted ending inventory	12,000 units

The coat racks are moulded and then painted. Each rack requires four kilograms of metal, which cost $2.50 per kilogram. The beginning inventory of materials is 4,000 kilograms. Young Products wants to have 6,000 kilograms of metal in inventory at the end of the quarter. Each rack produced requires 30 minutes of direct labour time, which is billed at $9 per hour.

Required:

1. Prepare a sales budget for the first quarter.
2. Prepare a production budget for the first quarter.
3. Prepare a direct materials purchases budget for the first quarter.
4. Prepare a direct labour budget for the first quarter.

Solution:

1.

Young Products
Sales Budget
For the First Quarter

Units	100,000
Unit selling price	× $15
Sales	$1,500,000

2.

Young Products
Production Budget
For the First Quarter

Sales (in units)	100,000
Desired ending inventory	12,000
Total needs	112,000
Less: Beginning inventory	8,000
Units to be produced	104,000

3.

Young Products
Direct Materials Purchases Budget
For the First Quarter

Units to be produced	104,000
Direct materials per unit (kg)	× 4
Production needs (kg)	416,000
Desired ending inventory (kg)	6,000
Total needed (kg)	422,000
Less: Beginning inventory (kg)	4,000
Materials to be purchased (kg)	418,000
Cost per kilogram	× $2.50
Total purchase cost	$1,045,000

4.

Young Products
Direct Labour Budget
For the First Quarter

Units to be produced	104,000
Labour time per unit	× 0.5
Total hours needed	52,000
Wage per hour	× $9
Total direct labour cost	$468,000

II. Flexible Budgeting

Archambault Company manufactures backpacks, messenger bags, and rolling duffel bags. Archambault's accountant has estimated the following cost formulas for overhead:

$$\text{Indirect labour cost} = \$90{,}000 + \$0.50 \text{ per direct labour hour}$$
$$\text{Maintenance} = \$45{,}000 + \$0.40 \text{ per machine hour}$$
$$\text{Power} = \$0.15 \text{ per machine hour}$$
$$\text{Depreciation} = \$150{,}000$$
$$\text{Other} = \$63{,}000 + \$1.30 \text{ per direct labour hour}$$

In the coming year, Archambault is considering three budgeting scenarios: conservative (assumes increased competition from other companies), expected, and optimistic (assumes a particularly robust economy). Anticipated quantities sold of each type of product appear in the following table:

Product	Conservative	Expected	Optimistic
Backpacks	50,000	100,000	150,000
Messenger bags	20,000	40,000	80,000
Rolling duffel bags	15,000	25,000	50,000

The standard amounts for one unit of each type of product are as follows:

	Backpacks	Messenger Bags	Rolling Duffel Bags
Direct materials	$5.00	$4.00	$8.00
Direct labour hours	1.2 hours	1.0 hour	2.5 hours
Machine hours	1.0 hour	0.75 hour	2.0 hours

Direct labour costs $8 per hour.

Required:

1. Prepare an overhead budget for the three potential scenarios.
2. Now, suppose that the actual level of activity for the year was 120,000 backpacks, 45,000 messenger bags, and 40,000 rolling duffel bags. Actual overhead costs were as follows:

Indirect labour	$230,400
Maintenance	145,500
Power	38,000
Depreciation	150,000
Other	435,350

Prepare a performance report for overhead costs.

Solution:

1.

Direct Labour Hours	Conservative	Expected	Optimistic
Backpacks (@ 1.2 DLH)	60,000	120,000	180,000
Messenger bags (@ 1.0 DLH)	20,000	40,000	80,000
Rolling duffel bags (@ 2.5 DLH)	37,500	62,500	125,000
Total direct labour hours	117,500	222,500	385,000

Machine Hours	Conservative	Expected	Optimistic
Backpacks (@ 1.0 MHr.)	50,000	100,000	150,000
Messenger bags (@ 0.75 MHr.)	15,000	30,000	60,000
Rolling duffel bags (@ 2.0 MHr.)	30,000	50,000	100,000
Total machine hours	95,000	180,000	310,000

Flexible Overhead Budget	Conservative	Expected	Optimistic
Variable overhead:			
Indirect labour ($0.50 × DLH)	$ 58,750	$111,250	$ 192,500
Maintenance ($0.40 × MHr.)	38,000	72,000	124,000
Power ($0.15 × MHr.)	14,250	27,000	46,500
Other ($1.30 × DLH)	152,750	289,250	500,500
Total variable overhead	$263,750	$499,500	$ 863,500
Fixed overhead:			
Indirect labour	$ 90,000	$ 90,000	$ 90,000
Maintenance	45,000	45,000	45,000
Depreciation	150,000	150,000	150,000
Other	63,000	63,000	63,000
Total fixed overhead	348,000	348,000	348,000
Total overhead	$611,750	$847,500	$1,211,500

2. Flexible budget based on actual output:

	Direct Labour Hours	Machine Hours
Backpacks:		
(1.2 × 120,000)	144,000	
(1.0 × 120,000)		120,000
Messenger bags:		
(1.0 × 45,000)	45,000	
(0.75 × 45,000)		33,750
Rolling duffel bags:		
(2.5 × 40,000)	100,000	
(2.0 × 40,000)		80,000
Total	289,000	233,750

	Flexible Budget Amount*	Actual	Variance
Indirect labour	$234,500	$230,400	$4,100 F
Maintenance	138,500	145,500	7,000 U
Power	35,063	38,000	2,937 U
Depreciation	150,000	150,000	—
Other	438,700	435,350	3,350 F
Total overhead	$996,763	$999,250	$2,487 U

*Indirect labour = $\$90,000 + (\$0.50 \times 289,000)$
Maintenance = $\$45,000 + (\$0.40 \times 233,750)$
Power = $\$0.15 \times 233,750$
Other = $\$63,000 + (\$1.30 \times 289,000)$

Key Terms

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Discussion Questions

1. Define *budget*. How are budgets used in planning?
2. Define *control*. How are budgets used to control?
3. Discuss some of the reasons for budgeting.
4. What is the master budget? An operating budget? A financial budget?
5. Explain the role of a sales forecast in budgeting. What is the difference between a sales forecast and a sales budget?
6. All budgets depend on the sales budget. Is this true? Explain.
7. What is an accounts receivable aging schedule? Why is it important?
8. Suppose that the vice president of sales is a particularly pessimistic individual. If you were in charge of developing the master budget, how, if at all, would you be influenced by this knowledge?
9. Suppose that the controller of your company's largest factory is a particularly optimistic individual. If you were in charge of developing the master budget, how, if at all, would you be influenced by this knowledge?
10. What impact does the learning curve have on budgeting? What specific budgets might be affected? (*Hint:* Refer to Chapter 2 for material on the learning curve.)
11. While many small firms do not put together a complete master budget, nearly every firm creates a cash budget. Why do you think that is so?
12. Discuss the shortcomings of the traditional master budget. In what situations would the master budget perform well?
13. Define *static budget*. Give an example that shows how reliance on a static budget could mislead management.
14. What are the two meanings of a flexible budget? How is the first type of flexible budget used? The second type?
15. What are the steps involved in building an activity-based budget? How do these steps differentiate the ABB from the master budget?

Cornerstone Exercises

OBJECTIVE 2

CORNERSTONE 8-1

SERVICE

Cornerstone Exercise 8-1 SALES BUDGET

StrikeSmart Company manufactures and sells soccer balls for teams of children in elementary and high school. StrikeSmart's best-selling lines are the training ball line—durable soccer balls for training and practice; and the match ball line—high performance soccer balls used in games. In the first four months of next year, StrikeSmart expects to sell the following:

	Training Balls		Match Balls	
	Units	Selling Price	Units	Selling Price
January	70,000	$9.50	10,000	$18.00
February	65,000	$9.50	8,000	$18.00
March	100,000	$9.50	15,000	$18.00
April	120,000	$9.50	25,000	$18.00

Required:

1. Construct a sales budget for StrikeSmart for the first three months of the coming year. Show total sales for each product line by month and in total for the first quarter.
2. ***What if*** StrikeSmart added a third line—tournament quality soccer balls that were expected to take 40 percent of the units sold of the match balls and would have a selling price of $40 each? Prepare a sales budget for StrikeSmart for the first three months of the coming year. Show total sales for each product line by month and in total for the first quarter.

Cornerstone Exercise 8-2 PRODUCTION BUDGET

OBJECTIVE 2
CORNERSTONE 8-2

Refer to **Cornerstone Exercise 8-1**, through Requirement 1. StrikeSmart requires ending inventory of product to equal 20 percent of the next month's unit sales. Beginning inventory in January was 10,000 training balls and 1,500 match balls.

Required:

1. Construct a production budget for each of the two product lines for StrikeSmart Company for the first three months of the coming year.
2. ***What if*** StrikeSmart wanted a production budget for the two product lines for the month of April? What additional information would you need to prepare this budget?

Cornerstone Exercise 8-3 DIRECT MATERIALS PURCHASES BUDGET

OBJECTIVE 2
CORNERSTONE 8-3

Refer to **Cornerstone Exercise 8-2** for the production budgets for training balls and match balls. Every training ball requires 0.7 square metre of polyvinyl chloride panels, one bladder with valve (to fill with air), and 3 grams of glue. StrikeSmart's policy is that 10 percent of the following month's production needs for raw materials be ending inventory. Beginning inventory in January for all raw materials met this requirement.

Required:

1. Construct a direct materials purchases budget for each type of raw materials for the training ball line for January and February of the coming year.
2. ***What if*** StrikeSmart increased the ending inventory percentage to 20 percent of the next month's production needs? What impact would that have on the direct materials purchases budgets prepared in Requirement 1?

Cornerstone Exercise 8-4 DIRECT LABOUR BUDGET FOR SERVICE

OBJECTIVE 2
CORNERSTONE 8-4

The School of Accountancy and Finance of Ryerson University is planning its annual fundraising campaign. This year, the school is planning a call-a-thon and will ask the Accounting and Finance Society (AFS) members to volunteer to make phone calls to a list of 5,000 alumni. The dean's office has agreed to let the AFS use their offices from 6 p.m. to 9 p.m. each weekday so that they will have access to phones. Each volunteer will be provided with a phone and a script with an introduction and suggested responses to various questions that had been asked in the past. Carol Johnson, AFS faculty advisor, estimates the following:

1. Of the 5,000 phone numbers, roughly 10 percent will be wrong numbers (because alumni change addresses/phone numbers without updating the university records). In that case, the student is instructed to apologize to the answering party, hang up, and move on to the next phone number. Each of these calls takes about three minutes.
2. Another 15 percent will be correct numbers, but no one is home and Call Answer picks up. In that case, the student is instructed to simply hang up and move on to the next phone number. Each of these calls takes about two minutes.
3. Each time an alumnus answers the phone, the student is instructed to introduce him or herself and read the scripted introduction. The student is encouraged to engage the alumnus in conversation and reminiscences about Ryerson University, and bring the alum up to date on the wonderful things that are happening in the AFS. Some calls are longer, some shorter, but the average call length is 10 minutes.

Required:

1. Prepare a direct labour budget, in hours, for the fundraising call-a-thon. If 15 students volunteer, how many evenings will the call-a-thon take? (Round to two significant digits.)
2. ***What if*** the call-a-thon can be moved to the Ryerson University Foundation phone bank? That facility has an automated calling system that automatically dials the phone numbers and routes all answered calls directly to students. As a result, no time is spent dialling and listening to Call Answer. The time savings due to having the numbers automatically dialled and routed mean that the average length of a wrong

number call drops to one minute and the average length of an alumni call drops to eight minutes. Prepare a direct labour budget, in hours, for the fundraising call-a-thon at Ryerson. If 15 students volunteer, how many evenings will the call-a-thon take? (Round to two significant digits.)

OBJECTIVE 2

CORNERSTONE 8-5

Cornerstone Exercise 8-5 OVERHEAD BUDGET

Sussman Company cleans and applies powder coat paint to metal items on a job-order basis. Sussmann has budgeted the following amounts for various overhead categories in the coming year.

Supplies	$264,000
Gas	60,000
Indirect labour	180,000
Supervision	75,000
Depreciation on equipment	60,000
Depreciation on the building	45,000
Rental of special equipment	12,000
Electricity (for lighting, heating, and air conditioning)	32,400
Telephone	4,300
Landscaping service	1,200
Other overhead	50,000

In the coming year, Sussman expects to powder coat 160,000 units. Each unit takes 1.5 direct labour hours. Sussman has found that supplies and gas (used to run the drying ovens—all units pass through the drying ovens after powder coat paint is applied) tend to vary with the number of units produced. All other overhead categories are considered to be fixed.

Required:

1. Calculate the number of direct labour hours Sussman must budget for the coming year. Calculate the variable overhead rate. Calculate the total fixed overhead for the coming year.
2. Prepare an overhead budget for Sussman for the coming year. Show the total variable overhead, total fixed overhead, and total overhead. Calculate the fixed overhead rate and the total overhead rate (rounded to the nearest cent).
3. ***What if*** Sussman had expected to make 150,000 units next year? Assume that the variable overhead per unit does not change and that the total fixed overhead amounts do not change. Calculate the new budgeted direct labour hours and prepare a new overhead budget. Calculate the fixed overhead rate and the total overhead rate (rounded to the nearest cent).

OBJECTIVE 2

CORNERSTONE 8-6

Cornerstone Exercise 8-6 ENDING FINISHED GOODS INVENTORY BUDGET

Play-Disc makes Frisbee-type plastic discs. Each 12 cm diameter plastic disc has the following manufacturing costs:

Direct materials	$1.67
Direct labour	0.56
Variable overhead	0.72
Fixed overhead	1.80
Total unit cost	$4.75

For the coming year, Play-Disc expects to make 300,000 plastic discs and to sell 285,000 of them. Budgeted beginning inventory in units is 16,000 with unit cost of $4.75. (There are no beginning or ending inventories of work in process.)

Required:

1. Prepare an ending finished goods inventory budget for Play-Disc for the coming year.
2. ***What if*** sales increased to 290,000 discs? How would that affect the ending finished goods inventory budget? Calculate the value of budgeted ending finished goods inventory.

Cornerstone Exercise 8-7 COST OF GOODS SOLD BUDGET

OBJECTIVE 2
CORNERSTONE 8-7
SERVICE

Refer to **Cornerstone Exercise 8-6**.

Required:

1. Calculate the total budgeted cost of units produced for Play-Disc for the coming year. Show the cost of direct materials, direct labour, and overhead.
2. Prepare a cost of goods sold budget for Play-Disc for the year.
3. ***What if*** the beginning inventory of finished goods was $4,750? How would that affect the cost of goods sold budget?

Cornerstone Exercise 8-8 MARKETING EXPENSE BUDGET

OBJECTIVE 2
CORNERSTONE 8-8
SERVICE

Timothy Donaghy has developed a unique formula for growing hair. His proprietary lotion, used regularly for 45 days, will grow hair in bald spots (with varying degrees of success). Timothy calls his lotion Hair-Again and is selling it via the telephone and Internet. His major form of marketing is through 15-minute infomercials and Internet advertising. Timothy sells each 16-unit bottle of Hair-Again for $15 and pays a commission of 3 percent of sales to telephone operators who field the 1-800 phone calls from potential customers. Fixed marketing expenses for each quarter of the coming year include:

Internet banner ads	$ 7,600
Television time	10,000
Telephone operator time	4,000
Travel	3,000

In addition, early next year Timothy intends to develop and film the infomercial he will be showing on television. The one-time cost is expected to be $65,000. Timothy expects the following unit sales of Hair-Again:

Quarter 1	5,000
Quarter 2	15,000
Quarter 3	40,000
Quarter 4	35,000

Required:

1. Construct a marketing expense budget for Hair-Again for the coming year. Show total amounts by quarter and in total for the year.
2. ***What if*** the cost of television time rises to $15,000 in Quarters 2 through 4? How would that affect variable marketing expense? Fixed marketing expense? Total marketing expense?

Cornerstone Exercise 8-9 ADMINISTRATIVE EXPENSE BUDGET

OBJECTIVE 2
CORNERSTONE 8-9
SERVICE

Genia Landscaping Company provides monthly and weekly landscaping and maintenance services to residential customers in the Cambridge area. Genia has no variable administrative expense. Fixed administrative expenses for June, July, and August include:

Salaries	$9,600
Insurance	2,500
Depreciation	3,700
Accounting services	500

Required:

1. Construct an administrative expense budget for Genia Landscaping Company for the three summer months. Show total amounts by month and in total for the three-month period.
2. ***What if*** Genia Landscaping Company's insurance rates increased at the beginning of July to $2,600 per month? How would that affect monthly administrative expense?

Cornerstone Exercise 8-10 BUDGETED INCOME STATEMENT

OBJECTIVE 2
CORNERSTONE 8-10
SERVICE

Chang Company makes and sells costume jewellery. For the coming year, it expects sales of $15.9 million and cost of goods sold of $8.75 million. Advertising is a key part of

Chang's business strategy, and total marketing expense for the year is budgeted at $2.8 million. Total administrative expenses are expected to be $675,000. Chang has no interest expense. Income taxes are paid at the rate of 40 percent of operating income.

Required:

1. Construct a budgeted income statement for Chang Company for the coming year.
2. ***What if*** Chang had interest payments of $500,000 during the year? What effect would that have on operating income? On income before taxes? On net income?

OBJECTIVE 3
CORNERSTONE 8-11

Cornerstone Exercise 8-11 CASH RECEIPTS BUDGET AND ACCOUNTS RECEIVABLE AGING SCHEDULE

Davidar Company manufactures and sells industrial products. For the next year, 2013, Davidar has budgeted the follow sales:

Quarter 1	$2,500,000
Quarter 2	3,000,000
Quarter 3	3,100,000
Quarter 4	2,900,000

In Davidar's experience, 10 percent of sales are paid in cash. Of the sales on account, 75 percent are collected in the quarter of sale; 15 percent are collected in the quarter following the sale; and 6 percent are collected in the second quarter after the sale. The remaining 4 percent are never collected. Total sales for the third quarter of the current year are $2,800,000 and for the fourth quarter of the current year are $2,400,000.

Required:

1. Calculate cash sales and credit sales expected in each quarter of 2013.
2. Construct a cash receipts budget including an accounts receivable aging schedule for Davidar Company for each quarter of the coming year, showing the cash sales and the cash collections from credit sales.
3. ***What if*** a recession led Davidar's top management to assume that in the coming year 10 percent of credit sales would never be collected? The expected payment percentages in the quarter of sale and the quarter after sale are assumed to be the same. How would that affect cash received in each quarter?

OBJECTIVE 3
CORNERSTONE 8-12
SERVICE

Cornerstone Exercise 8-12 CASH BUDGET

Jilly Company imports gift items from overseas and sells them to gift shops and department stores throughout Canada and the United States. Jilly Company provided the following information:

a. The October 31 balance in the cash account is $53,817.
b. All sales are on account. Sales in September were $900,000 and in October were $1,300,000.
c. November sales are expected to be $2,750,000.
d. In Jilly's experience, 60 percent of sales are collected in the month of sale and 35 percent are collected in the month following sale. The remaining credit sales are uncollectible.
e. Jilly purchases all merchandise on account. Purchases in September were $800,000 and in October were $950,000. November purchases are expected to be $2,750,000 as Jilly prepares for the Christmas buying season. Twenty-five percent of purchases are paid in the month of purchase, while the remainder is paid in the month following the purchase month.
f. Jilly Company has five employees who are paid a total of $34,500 per month. Due to timing issues, about 90 percent of total wages are paid in the month earned and the remaining 10 percent are paid in the following month.
g. Rent for office and warehouse space is $15,600 paid monthly in cash.
h. Utilities average $7,650 per month and are paid in cash.
i. In November, Jilly expects to pay employment taxes of $4,760.
j. Since Jilly imports product from overseas, customs duty and shipping to the central location of 20 percent of current monthly purchase cost must be paid in the month of purchase.
k. Other cash expenses for November are expected to be $37,400.

Required:

1. Prepare a cash budget for Jilly Company for the month of November.
2. ***What if*** Jilly faced a customs duty and shipping percentage of 25 percent? How would that affect the November cash budget?

Cornerstone Exercise 8-13 FLEXIBLE BUDGET FOR VARYING LEVELS OF ACTIVITY

OBJECTIVE 4
CORNERSTONE 8-13

Melton Company has the following budgeted variable costs per unit produced:

Direct materials	$3.40
Direct labour	1.30
Variable overhead:	
Supplies	0.23
Maintenance	0.19
Power	0.18

Budgeted fixed overhead costs per month include supervision of $110,000, depreciation of $135,000, and other overhead of $245,000.

Required:

1. Prepare a flexible budget for all costs of production for the following levels of production: 210,000 units, 220,000 units, and 230,000 units.
2. What is the per-unit total product cost for each of the production levels from Requirement 1? (Round each unit cost to the nearest cent.)
3. ***What if*** Melton's cost of maintenance rose to $0.22 per unit? How would that affect the unit product costs calculated in Requirement 2?

Cornerstone Exercise 8-14 FLEXIBLE BUDGET FOR VARYING LEVELS OF ACTIVITY

OBJECTIVE 4
CORNERSTONE 8-14

Refer to **Cornerstone Exercise 8-13**. In March, Melton Company produced 216,500 units and had the following actual costs:

Direct materials	$741,250
Direct labour	282,500
Supplies	50,050
Maintenance	41,420
Power	37,000
Supervision	110,250
Depreciation	135,000
Other overhead	245,250

Required:

1. Prepare a performance report for Melton Company comparing actual costs with the flexible budget for actual units produced.
2. ***What if*** Melton's actual direct materials cost were $736,100? How would that affect the variance for direct materials? The total cost variance?

Exercises

Exercise 8-15 PRODUCTION BUDGET

OBJECTIVE 2

Siren Company produces consumer products. The sales budget for four months of the year is presented below.

	Unit Sales	Dollar Sales
July	23,400	$ 690,000
August	35,600	1,068,000
September	34,000	1,020,000
October	28,000	840,000

Company policy requires that ending inventories for each month be 20 percent of next month's sales. At the beginning of July, the beginning inventory of consumer products met that policy.

Required:

Prepare a production budget for the third quarter of the year. Show the number of units that should be produced each month as well as for the quarter in total.

OBJECTIVE 2

Exercise 8-16 SALES AND PRODUCTION BUDGETS

Feingold Company produces two products: the deluxe and the standard. The deluxe sells for $40, and the standard sells for $10. Projected sales of the two models for the coming four quarters are given below.

	Deluxe	Standard
First quarter	12,000	90,000
Second quarter	14,300	88,400
Third quarter	16,600	92,000
Fourth quarter	20,000	91,600

The president of the company believes that the projected sales are realistic and can be achieved by the company. In the factory, the production supervisor has received the projected sales figures and gathered information needed to compile production budgets. He found that 1,300 deluxes and 1,170 standards were in inventory on January 1. Company policy dictates that ending inventory should equal 20 percent of the next quarter's sales for deluxes and 10 percent of next quarter's sales for standards.

Required:

1. Prepare a sales budget for each quarter and for the year in total. Show sales by product and in total for each time period.
2. What factors might Feingold Company have considered in preparing the sales budget?
3. Prepare a separate production budget for each product for each of the first three quarters of the year.

OBJECTIVE 2

Exercise 8-17 DIRECT MATERIALS PURCHASES BUDGET, DIRECT LABOUR BUDGET

New Beginnings Co. (NBCO) employs special needs people who produce stuffed toy animals; one of these is "Hootie the Owl." Each hootie takes 0.25 metres of fabric (white with irregular black splotches) and eight grams of polyfibrefill. Material costs $3.50 per metre and polyfibrefill is $0.05 per gram. NBCO has budgeted production of hooties for the next four months as follows:

	Units
October	42,000
November	90,000
December	50,000
January	40,000

Inventory policy requires that sufficient fabric be in ending monthly inventory to satisfy 20 percent of the following month's production needs and sufficient polyfibrefill be in inventory to satisfy 40 percent of the following month's production needs. Inventory of fabric and polyfibrefill at the beginning of October equals exactly the amount needed to satisfy the inventory policy.

Each hootie produced requires (on average) 0.35 direct labour hour. The average cost of direct labour is $14 per hour.

Required:

1. Prepare a direct materials purchases budget of fabric for the last quarter of the year showing purchases in units and in dollars for each month and for the quarter in total.

2. Prepare a direct materials purchases budget of polyfibrefill for the last quarter of the year showing purchases in units and in dollars for each month and for the quarter in total.
3. Prepare a direct labour budget for the last quarter of the year showing the hours needed and the direct labour cost for each month and for the quarter in total.

Exercise 8-18 SALES FORECAST AND BUDGET

OBJECTIVE 2

Audio-2-Go Inc. manufactures MP3 players. Models A-1, A-2, and A-3 are small and light. They are attached to armbands and use flash memory. Models A-4 and A-5 are somewhat larger and use a built-in hard drive; they can be put into fanny packs for use while working out. It is now early 2013, and Audio-2-Go's budgeting team is finalizing the sales budget for 2013. Sales in units and dollars for 2012 were as follows:

Model	Number Sold	Price	Revenue
A-1	20,000	$ 50	$1,000,000
A-2	30,000	75	2,250,000
A-3	50,000	90	4,500,000
A-4	15,000	120	1,800,000
A-5	2,000	200	400,000
			$9,950,000

In looking over the 2012 sales figures, Audio-2-Go's sales budgeting team recalled the following:

a. Model A-1 costs were rising faster than the price could rise. Preparatory to phasing out this model, Audio-2-Go Inc. planned to slash advertising for this model and raise its price by 30 percent. The number of units of Model A-1 to be sold was forecast to be 50 percent of 2012 units.
b. Model A-5 was introduced on November 1, 2012. It contains a built-in 20 GB hard drive and can be synchronized with several popular music software programs. Audio-2-Go brought out this model to match competitors' audio players, but the price is so much higher than other Audio-2-Go products that sales have been disappointing. The company plans to discontinue this model on June 30, 2013, and thinks that 2013 monthly sales will remain at the 2012 level if the sales price remains at the 2012 level.
c. Audio-2-Go plans to introduce Model A-6 on July 1, 2013. It will be a high-end player that will be lighter and more versatile than Model A-5 (which it will replace). The target price for this model is $180; unit sales are estimated to equal 2,500 per month.
d. A competitor has announced plans to introduce an improved version of Model A-3. Audio-2-Go believes that the Model A-3 price must be cut 20 percent to maintain unit sales at the 2012 level.
e. It was assumed that unit sales of all other models would increase by 10 percent, prices remaining constant.

Required:

Prepare a sales forecast by product and in total for Audio-2-Go Inc. for 2013.

Exercise 8-19 PURCHASES BUDGET

OBJECTIVE 2

SERVICE

Tiger Drug Store carries a variety of health and beauty aids, including 500-count bottles of vitamins. The sales budget for vitamins for the first six months of the year is presented below.

	Unit Sales	Dollar Sales
January	170	$1,530
February	160	1,440
March	180	1,620
April	190	1,710
May	210	1,890
June	200	1,800

The owner of Tiger Drug believes that ending inventories should be sufficient to cover 10 percent of the next month's projected sales. On January 1, 23 bottles of vitamins were in inventory.

Required:

1. Prepare a merchandise purchases budget in bottles of vitamins for as many months as you can.
2. If vitamins are priced at cost plus 80 percent, what is the dollar cost of purchases for each month of your purchases budget?

OBJECTIVE 3

Exercise 8-20 SCHEDULE OF CASH RECEIPTS

SERVICE

Rosita Flores owns Rosita's Mexican Restaurant in Thunder Bay, Ontario. Rosita's is an affordable restaurant near campus and several hotels. Rosita accepts cash and cheques. Cheques are deposited immediately. The bank charges $0.50 per cheque, the amount per cheque averages $75. "Bad" cheques that Rosita cannot collect make up 3 percent of cheque revenue.

During a typical month, Rosita's has sales of $45,000. About 80 percent are cash sales. Estimated sales for the next three months are as follows:

April	$32,000
May	45,000
June	56,000

Required:

Prepare a schedule of cash receipts for May and June. (Round all amounts to the nearest dollar.)

OBJECTIVE 3

Exercise 8-21 SCHEDULE OF CASH RECEIPTS

SERVICE

Refer to **Exercise 8-20**. Rosita thinks that it may be time to refuse to accept cheques and to start accepting credit cards. She is negotiating with VISA/MasterCard and American Express, and she would start the new policy on April 1. Rosita estimates that with the drop in sales from the "no cheques" policy and the increase in sales from the acceptance of credit cards, the net increase in sales will be 30 percent. The credit cards do involve added costs as follows:

VISA/MasterCard: Rosita will accumulate these credit card receipts throughout the month and submit them in one bundle for payment on the last day of the month. The money will be credited to her account by the fifth day of the following month. A fee of 3.5 percent is charged by the credit card company.

American Express: Rosita will accumulate these receipts throughout the month and mail them to American Express for payment on the last day of the month. American Express will credit her account by the sixth day of the following month. A fee of 5.5 percent is charged by American Express.

Rosita estimates the following breakdown of revenues among the various payment methods.

Cash	10%
VISA/Mastercard	75
American Express	15

Required:

Prepare a schedule of cash receipts for May and June that incorporates the changes in policy. (Round all amounts to the nearest dollar.)

OBJECTIVE 3

Exercise 8-22 CASH BUDGET

SERVICE

Bruce "Bruiser" Hawkins, former all-star football player, owns a retail store that sells new and used sporting equipment. Bruiser has requested a cash budget for October. After examining the records of the company, you find the following:

a. Cash balance on October 1 is $1,118.
b. Actual sales for August and September are as follows:

	August	September
Cash sales	$ 5,000	$ 6,000
Credit sales	60,000	58,000
Total sales	$65,000	$64,000

c. Credit sales are collected over a three-month period: 35 percent in the month of sale, 45 percent in the next month, and 16 percent in the second month after the sale. The remaining sales are uncollectible.
d. Inventory purchases average 70 percent of a month's total sales. Of those purchases, 40 percent are paid for in the month of purchase. The remaining 60 percent are paid for in the following month.
e. Salaries and wages total $4,200 per month.
f. Rent is $2,400 per month.
g. Taxes to be paid in October are $965.
h. Bruiser usually withdraws $3,500 each month as his salary.
i. Advertising is $500 per month.
j. Other operating expenses total $3,800 per month.
k. Internet and telephone fees are $320 per month.

Bruiser tells you that he expects cash sales of $6,500 and credit sales of $55,000 for October. He likes to have $3,000 on hand at the end of the month and is concerned about the potential October ending balance.

Required:

1. Prepare a cash budget for October. Include supporting schedules for cash collections and cash payments.
2. Did the business meet Bruiser's desired ending cash balance for October? Assuming that the owner has no hope of establishing a line of credit for the business, what recommendations would you give the owner for meeting the desired cash balance?

Exercise 8-23 SCHEDULE OF CASH RECEIPTS

OBJECTIVE 3

SERVICE

Del Spencer is the owner and founder of Del Spencer's Men's Clothing Store. Del Spencer's has its own house charge accounts and has found from past experience that 10 percent of its sales are for cash. The remaining 90 percent are on credit. An aging schedule for accounts receivable reveals the following pattern:

15 percent of credit sales are paid in the month of sale.
65 percent of credit sales are paid in the first month following the sale.
14 percent of credit sales are paid in the second month following the sale.
6 percent of credit sales are never collected.

Credit sales that have not been paid until the second month following the sale are considered overdue and are subject to a 3 percent late charge.

Del Spencer's has developed the following sales forecast:

May	$60,000
June	55,000
July	45,000
August	56,000
September	83,000

Required:

Prepare a schedule of cash receipts for August and September.

Exercise 8-24 CASH DISBURSEMENTS SCHEDULE

OBJECTIVE 3

SERVICE

Refer to **Exercise 8-23**. Del Spencer's purchases clothing evenly throughout the month. All purchases are on account. On the first of every month, Jana Spencer, Del's wife, pays for all of the previous month's purchases. Terms are 2/10, n/30 (i.e., a 2 percent

discount can be taken if the bill is paid within 10 days; otherwise, the entire amount is due within 30 days).

The forecast purchases for the months of May through September are as follows:

May	$30,000
June	27,500
July	22,500
August	28,000
September	41,500

Required:

1. Prepare a cash disbursements schedule for the months of August and September. (Round all cash amounts to the nearest dollar.)
2. Now, suppose that Del wants to see what difference it would make to have someone pay for any purchases that have been made three times per month, on the 1st, the 11th, and the 21st. Prepare a cash disbursements schedule for the months of July and August assuming this new payment schedule. (Round all cash amounts to the nearest dollar.)
3. Suppose that Jana (who works full time as a schoolteacher and is the mother of two small children) does not have time to make payments on two extra days per month and that a temporary employee is hired on the 11th and 21st at $20 per hour, for four hours each of those two days. Is this a good decision? Explain.

OBJECTIVE 4

Exercise 8-25 FLEXIBLE BUDGET

In an attempt to improve budgeting, the controller for Hilbert Products has developed a flexible budget for overhead costs. Hilbert Products makes two types of paper-based cloths: counter wipes and floor wipes. Hilbert expects to produce 500,000 rolls of each product during the coming year. Counter wipes require 0.02 direct labour hour per roll, and floor wipes require 0.06. The controller has developed the following cost formulas for each of the four overhead items:

	Cost Formula
Maintenance	$18,000 + $0.25 *DLH*
Power	$0.50 *DLH*
Indirect labour	$48,600 + $1.50 *DLH*
Rent	$31,500

Required:

1. Prepare an overhead budget for the expected activity level for the coming year.
2. Prepare an overhead budget that reflects production that is 10 percent higher than expected (for both products) and a budget for production that is 20 percent lower than expected.

OBJECTIVE 4

Exercise 8-26 FLEXIBLE BUDGET

Refer to **Exercise 8-25**. At the end of the year, Hilbert Products actually produced 525,000 rolls of counter wipes and 497,000 of floor wipes. The actual overhead costs incurred were:

Maintenance	$ 29,050
Power	19,900
Indirect labour	109,000
Rent	31,500

Required:

Prepare a performance report for the period.

OBJECTIVE 2 4

Exercise 8-27 SALES FORECAST AND FLEXIBLE BUDGET

Olympus Inc. manufactures three models of mattresses: the Sleepeze, the Plushette, and the Ultima. Forecast sales for next year are 15,000 for the Sleepeze, 12,000 for the Plushette, and 5,000 for the Ultima. Gene Dixon, vice president of sales, has provided the following information:

a. Salaries for his office (including himself at $65,000, a marketing research assistant at $40,000, and an administrative assistant at $25,000) are budgeted for $130,000 next year.
b. Depreciation on the offices and equipment is $20,000 per year.
c. Office supplies and other expenses total $21,000 per year.
d. Advertising has been steady at $20,000 per year. However, the Ultima is a new product and will require extensive advertising to educate consumers on the unique features of this high-end mattress. Gene believes the company should spend 15 percent of first-year Ultima sales for a print and television campaign.
e. Commissions on the Sleepeze and Plushette lines are 5 percent of sales. These commissions are paid to independent jobbers who sell the mattresses to retail stores.
f. Last year, shipping for the Sleepeze and Plushette lines averaged $50 per unit sold. Gene expects the Ultima line to ship for $75 per unit sold since this model features a larger mattress.

Required:

1. Suppose that Gene is considering three sales scenarios as follows:

	Pessimistic		Expected		Optimistic	
	Price	Quantity	Price	Quantity	Price	Quantity
Sleepeze	$180	12,500	$ 200	15,000	$ 200	18,000
Plushette	300	10,000	350	12,000	360	14,000
Ultima	900	2,000	1,000	5,000	1,200	5,000

Prepare a revenue budget for the Sales Division for the coming year for each scenario.
2. Prepare a flexible expense budget for the Sales Division for the three scenarios above.

Exercise 8-28 ACTIVITY-BASED BUDGET

OBJECTIVE 5

Refer to **Exercise 8-27**. Suppose Gene determines that next year's Sales Division activities include the following:

Research—researching current and future conditions in the industry

Shipping—arranging for shipping of mattresses and handling calls from purchasing agents at retail stores to trace shipments and correct errors

Jobbers—coordinating the efforts of the independent jobbers who sell the mattresses

Basic ads—placing print and television ads for the Sleepeze and Plushette lines

Ultima ads—choosing and working with the advertising agency on the Ultima account

Office management—operating the Sales Division office

The percentage of time spent by each employee of the Sales Division on each of the above activities is given in the following table:

	Gene	Research Assistant	Administrative Assistant
Research	—	75%	—
Shipping	30%	—	20%
Jobbers	15	10	20
Basic ads	—	15	40
Ultima ads	30	—	5
Office management	25	—	15

Additional information is as follows:

a. Depreciation on the office equipment belongs to the office management activity.
b. Of the $21,000 for office supplies and other expenses, $5,000 can be assigned to telephone costs which can be split evenly between the shipping and jobbers' activities. An additional $2,400 per year is attributable to Internet connections and fees,

and the bulk of these costs (80 percent) are assignable to research. The remainder is a cost of office management. All other office supplies and costs are assigned to the office management activity.

Required:

1. Prepare an activity-based budget for next year by activity. Use the expected level of sales activity.
2. On the basis of the budget prepared in Requirement 1, advise Gene regarding actions that might be taken to reduce expenses.

Problems

OBJECTIVE ➤ 2 3

Problem 8-29 OPERATING BUDGET, COMPREHENSIVE ANALYSIS

Cartwright Inc. produces wiring harness assemblies used in the production of semi-trailer trucks. The wiring harness assemblies are sold to various truck manufacturers around the world. Projected sales in units for the coming four months are given below.

January	14,000
February	18,000
March	22,000
April	24,000

The following data pertain to production policies and manufacturing specifications followed by Cartwright:

a. Finished goods inventory on January 1 is 13,000 units. The desired ending inventory for each month is 20 percent of the next month's sales.
b. The data on materials used are as follows:

Direct Material	Per-Unit Usage	Unit Cost
Part #A78	4	$5
Part #D22	3	6

Inventory policy dictates that sufficient materials be on hand at the beginning of the month to satisfy 50 percent of the month's production needs. This is exactly the amount of material on hand on January 1.

c. The direct labour used per unit of output is one and one-half hours. The average direct labour cost per hour is $15.
d. Overhead each month is estimated using a flexible budget formula. (Activity is measured in direct labour hours.)

	Fixed Cost Component	Variable Cost Component
Supplies	$ —	$1.00
Power	—	0.20
Maintenance	12,500	1.10
Supervision	14,000	—
Depreciation	45,000	—
Taxes	4,300	—
Other	86,000	1.60

e. Monthly selling and administrative expenses are also estimated using a flexible budgeting formula. (Activity is measured in units sold.)

	Fixed Costs	Variable Costs
Salaries	$30,000	—
Commissions	—	$1.40
Depreciation	5,000	—
Shipping	—	2.60
Other	13,000	0.60

f. The unit selling price of the wiring harness assembly is $85.
g. In February, the company plans to purchase land for future expansion. The land costs $237,500.
h. All sales and purchases are for cash. The cash balance on January 1 equals $62,900. If the firm develops a cash shortage by the end of the month, sufficient cash is borrowed to cover the shortage. Any cash borrowed is repaid one month later, as is the interest due. The interest rate is 12 percent per annum.

Required:

Prepare a monthly operating budget for the first quarter with the following schedules:

1. Sales budget
2. Production budget
3. Direct materials purchases budget
4. Direct labour budget
5. Overhead budget
6. Selling and administrative expense budget
7. Ending finished goods inventory budget
8. Cost of goods sold budget
9. Budgeted income statement (ignore income taxes)
10. Cash budget

Problem 8-30 CASH BUDGET, PRO FORMA BALANCE SHEET

OBJECTIVE 3

SERVICE

Joe Lucchetti is the controller for Creighton Hardware Store. In putting together the cash budget for the fourth quarter of the year, he has assembled the following data.

a. Sales

July (actual)	$100,000
August (actual)	120,000
September (estimated)	90,000
October (estimated)	100,000
November (estimated)	135,000
December (estimated)	150,000

b. Each month, 20 percent of sales are for cash, and 80 percent are on credit. The collection pattern for credit sales is 20 percent in the month of sale, 50 percent in the following month, and 30 percent in the second month following the sale.
c. Each month, the ending inventory exactly equals 40 percent of the cost of next month's sales. The markup on goods is 33.33 percent of cost.
d. Inventory purchases are paid for in the month following purchase.
e. Recurring monthly expenses are as follows:

Salaries and wages	$10,000
Depreciation on plant and equipment	4,000
Utilities	1,000
Other	1,700

f. Property taxes of $15,000 are due and payable on September 15.
g. Advertising fees of $6,000 must be paid on October 20.
h. A lease on a new storage facility is scheduled to begin on November 2. Monthly payments are $5,000.
i. The company has a policy to maintain a minimum cash balance of $10,000. If necessary, it will borrow to meet its short-term needs. All borrowing is done at the beginning of the month. All payments on principal and interest are made at the end of the month. The annual interest rate is 9 percent. The company must borrow in multiples of $1,000.
j. A partially completed balance sheet as of August 31 is given below. (Accounts payable is for inventory purchases only.)

	Assets	Liabilities & Owners' Equity
Cash	$?	
Accounts receivable	?	
Inventory	?	
Plant and equipment	431,750	
Accounts payable		$?
Common shares		220,000
Retained earnings		268,750
Totals	$?	$?

Required:

1. Complete the balance sheet given in part (j).
2. Joe wants to see how the company is doing prior to starting the month of December. Prepare a cash budget for the months of September, October, and November and for the three-month period in total (the period begins on September 1). Provide a supporting schedule of cash collections.
3. Prepare a pro forma balance sheet as of November 30.

OBJECTIVE 4

Problem 8-31 FLEXIBLE BUDGET

The controller for Muir Company's Windsor plant is analyzing overhead in order to determine appropriate drivers for use in flexible budgeting. She decided to concentrate on the past 12 months since that time period was one in which there was little important change in technology, product lines, and so on. Data on overhead costs, number of machine hours, number of setups, and number of purchase orders are in the following table.

Month	Overhead Costs	Machine Hours	Number of Setups	Number of Purchase Orders
January	$ 32,296	1,000	20	216
February	31,550	930	18	250
March	36,280	1,100	21	300
April	36,867	1,050	23	270
May	36,790	1,170	22	285
June	37,800	1,200	25	240
July	40,024	1,235	27	237
August	39,256	1,190	24	303
September	33,800	1,070	20	255
October	33,779	1,210	22	195
November	37,225	1,207	23	270
December	27,500	1,084	15	150
Totals	$423,167	13,446	260	2,971

Required:

1. Calculate an overhead rate based on machine hours using the total overhead cost and total machine hours. (Round the overhead rate to the nearest cent and predicted overhead to the nearest dollar.) Use this rate to predict overhead for each of the 12 months.
2. Run a regression equation using only machine hours as the independent variable. Prepare a flexible budget for overhead for the 12 months using the results of this regression equation. (Round the intercept and x-coefficient to the nearest cent and predicted overhead to the nearest dollar.) Is this flexible budget better than the budget in Requirement 1? Why or why not?

Problem 8-32 FLEXIBLE BUDGET, MULTIPLE REGRESSION

OBJECTIVE 4

Refer to **Problem 8-31** for data.

Required:

1. Run a multiple regression equation using machine hours, number of setups, and number of purchase orders as independent variables. Prepare a flexible budget for overhead for the 12 months using the results of this regression equation. (Round the regression coefficients to the nearest cent and predicted overhead to the nearest dollar.) Which flexible budget is better—the one based on simple regression (with machine hours as the only independent variable) or the one based on multiple regression? Why?
2. Now, suppose that the controller remembers that the factory throws two big parties each year, one for Canada Day and the other for Christmas. Rerun the multiple regression with machine hours, number of setups, and number of purchase orders, and add a dummy variable called "Party." (This variable takes the value one for months with a factory-sponsored party, and zero otherwise.) Prepare a flexible budget for the 12 months using the results of this regression. Discuss the implications of using this new regression for decision making.

CMA Problems

CMA Problem 8-1 BUDGETED CASH COLLECTIONS, BUDGETED CASH PAYMENTS*

OBJECTIVE 3

SERVICE

Historically, Mapleridge Company has had no significant bad debt experience with its customers. Cash sales have accounted for 10 percent of total sales, and payments for credit sales have been received as follows:

45 percent of credit sales in the month of the sale.
35 percent of credit sales in the first subsequent month.
16 percent of credit sales in the second subsequent month.
4 percent of credit sales in the third subsequent month.
The forecast for both cash and credit sales is as follows.

January	$195,000
February	188,000
March	192,000
April	204,000
May	212,000

Required:

1. What is the forecasted cash inflow for Mapleridge Company for May?
2. Due to deteriorating economic conditions, Mapleridge Company has now decided that its cash forecast should include a bad debt adjustment of 2 percent of credit sales, beginning with sales for the month of April. Because of this policy change, what will happen to the total expected cash inflow related to sales made in April? *(CMA adapted)*

CMA Problem 8-2 PRODUCTION, PURCHASES, AND DIRECT LABOUR BUDGETS*

OBJECTIVE 2

Ingles Corporation is a manufacturer of tables sold to schools, restaurants, hotels, and other institutions. The table tops are manufactured by Ingles, but the table legs are purchased from an outside supplier. The Assembly Department takes a manufactured table top and attaches the four purchased table legs. It takes 16 minutes of labour to assemble a table. The company follows a policy of producing enough tables to ensure that 40 percent of next month's sales are in the finished goods inventory. Ingles also purchases sufficient materials to ensure that materials inventory is 60 percent of the following month's scheduled production. Ingles's sales budget in units for the next quarter is as follows:

July	2,450
August	2,900
September	2,100

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Ingles's ending inventories in units for July 31, 2013, are as follows:

Finished goods	1,900
Materials (legs)	4,000

Required:

1. Calculate the number of tables to be produced during August 2013.
2. Disregarding your response to Requirement 1, assume the required production units for August and September are 2,100 and 1,900, respectively, and the July 31, 2013, materials inventory is 4,000 units. Compute the number of table legs to be purchased in August.
3. Assume that Ingles Corporation will produce 2,340 units in September 2013. How many employees will be required for the Assembly Department in September? (Fractional employees are acceptable since employees can be hired on a part-time basis. Assume a 40-hour week and a 4-week month.) *(CMA adapted)*

OBJECTIVE 2

CMA Problem 8-3 PRODUCTION, DIRECT LABOUR, DIRECT MATERIALS, SALES BUDGETS, BUDGETED CONTRIBUTION MARGIN*

Janzen Company makes and sells high-quality glare filters for microcomputer monitors. John Crave, controller, is responsible for preparing Janzen's master budget and has assembled the following data for 2013. The direct labour rate includes wages, all employee-related benefits, and the employer's share of employment taxes. Labour-saving machinery will be fully operational by March. Also, as of March 1, the company's union contract calls for an increase in direct labour wages that is included in the direct labour rate. Janzen expects to have 9,000 glare filters in inventory at December 31, 2012, and has a policy of carrying 45 percent of the following month's projected sales in inventory.

	2013			
	January	February	March	April
Estimated unit sales	38,500	37,000	22,700	25,000
Sales price per unit	$80	$80	$75	$75
Direct labour hours per unit	3.0	3.0	2.5	2.5
Direct labour hourly rate	$15	$15	$17	$17
Direct materials cost per unit	$8	$8	$8	$8

Required:

1. Prepare the following monthly budgets for Janzen Company for the first quarter of 2013. Be sure to show supporting calculations.
   a. Production budget in units.
   b. Direct labour budget in hours.
   c. Direct materials cost budget.
   d. Sales budget.
2. Calculate the total budgeted contributions margin for Janzen Company for the first quarter of 2013. Be sure to show supporting calculations. *(CMA adapted)*

OBJECTIVE 3

CMA Problem 8-4 CASH BUDGET*

Friendly Freddie's is an independently owned major appliance and electronics discount chain with seven stores located in an Ontario metropolitan area. Rapid expansion has created the need for careful planning of cash requirements to ensure that the chain is able to replenish stock adequately and meet payment schedules to creditors. Fred Lau, founder of the chain, has established a banking relationship that provides a $200,000 line of credit to Friendly Freddie's. The bank requires that a minimum balance of $8,200 be kept in the chain's chequing account at the end of each month. When the balance goes below $8,200, the bank automatically extends the line of credit in multiples of $1,000 so that the chequing account balance is at least $8,200 at month-end.

Friendly Freddie's attempts to borrow as little as possible and repays the loans quickly in multiples of $1,000 plus 2 percent monthly interest on the entire loan balance.

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Interest payments and any principal payments are paid at the end of the month following the loan. The chain currently has no outstanding loans.

The following cash receipts and disbursements data apply to the fourth quarter of the current calendar year.

Estimated beginning cash balance	$ 8,800
Estimated cash sales:	
October	14,000
November	29,000
December	44,000
Sales on account:	
July (actual)	130,000
August (actual)	104,000
September (actual)	128,000
October (estimated)	135,000
November (estimated)	142,000
December (estimated)	188,000

Projected cash collection of sales on account is estimated to be 70 percent in the month following the sale, 20 percent in the second month following the sale, and 6 percent in the third month following the sale. The 4 percent beyond the third month following the sale is determined to be uncollectible. In addition, the chain is scheduled to receive $13,000 cash on a note receivable in October.

All inventory purchases are made on account as the chain has excellent credit with all vendors because of a strong payment history. The following information regarding inventory purchases is available.

Inventory Purchases	
September (actual)	$120,000
October (estimated)	112,000
November (estimated)	128,000
December (estimated)	95,000

Cash disbursements for inventory are made in the month following purchase using an average cash discount of 3 percent for timely payment. Monthly cash disbursements for operating expenses during October, November, and December are estimated to be $38,000, $41,000, and $46,000, respectively.

Required:

Prepare Friendly Freddie's cash budget for the months of October, November, and December showing all receipts, disbursements, and credit line activity, where applicable. *(CMA adapted)*

CMA Problem 8-5 PARTICIPATIVE VERSUS IMPOSED BUDGETING*

OBJECTIVE 6

SERVICE

An effective budget converts the goals and objectives of an organization into data. The budget serves as a blueprint for management's plans. The budget is also the basis for control. Management performance can be evaluated by comparing actual results with the budget.

Thus, creating the budget is essential for the successful operation of an organization. Finding the resources to implement the budget—that is, moving from a starting point to the ultimate goal—requires the extensive use of human resources. How managers perceive their roles in the process of budgeting is important to the successful use of the budget as an effective tool for planning, communicating, and controlling.

Required:

1. Discuss the behavioural implications of planning and control when a company's management employs: (a) an imposed budgetary approach, and (b) a participative budgetary approach.

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2. Communications plays an important role in the budgetary process whether a participative or an imposed budgetary approach is used.
   a. Discuss the differences between communication flows in these two budgetary approaches.
   b. Discuss the behavioural implications associated with the communication process for each of the budgetary approaches. *(CMA adapted)*

OBJECTIVE ➤ 1 6

CMA Problem 8-6 INFORMATION FOR BUDGETING, ETHICS*

Norton Company, a manufacturer of infant furniture and carriages, is in the initial stages of preparing the annual budget for the coming year. Scott Ford has recently joined Norton's accounting staff and is interested in learning as much as possible about the company's budgeting process. During a recent lunch with Thai Wong, sales manager, and Abdul Saif, production manager, Ford initiated the following conversation.

FORD: Since I'm new around here and am going to be involved with the preparation of the annual budget, I'd be interested in learning how the two of you estimate sales and production numbers.

WONG: We start out very methodically by looking at recent history, discussing what we know about current accounts, potential customers, and the general state of consumer spending. Then, we add that usual dose of intuition to come up with the best forecast we can.

SAIF: I usually take the sales projections as the basis for my projections. Of course, we have to make an estimate of what this year's closing inventories will be, which is sometimes difficult.

FORD: Why does that present a problem? There must have been an estimate of closing inventories in the budget for the current year.

SAIF: Those numbers aren't always reliable since Thai makes some adjustments to the sales numbers before passing them on to me.

FORD: What kind of adjustments?

WONG: Well, we don't want to fall short of the sales projections so we generally give ourselves a little breathing room by lowering the initial sales projection anywhere from 5 to 10 percent.

SAIF: So, you can see why this year's budget is not a very reliable starting point. We always have to adjust the projected production rates as the year progresses, and of course, this changes the ending inventory estimates. By the way, we make similar adjustments to expenses by adding at least 10 percent to the estimates; I think everyone around here does the same thing.

Required:

1. Thai Wong and Abdul Saif have described the use of budgetary slack.
   a. Explain why Wong and Saif behave in this manner, and describe the benefits they expect to realize from the use of budgetary slack.
   b. Explain how the use of budgetary slack can adversely affect Wong and Saif.
2. As a management accountant, Scott Ford believes that the behaviour described by Thai Wong and Abdul Saif may be unethical and that he may have an obligation not to support this behaviour. Explain why the use of budgetary slack may be unethical in terms of the general standards of competency, integrity, and credibility as you understand them. *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

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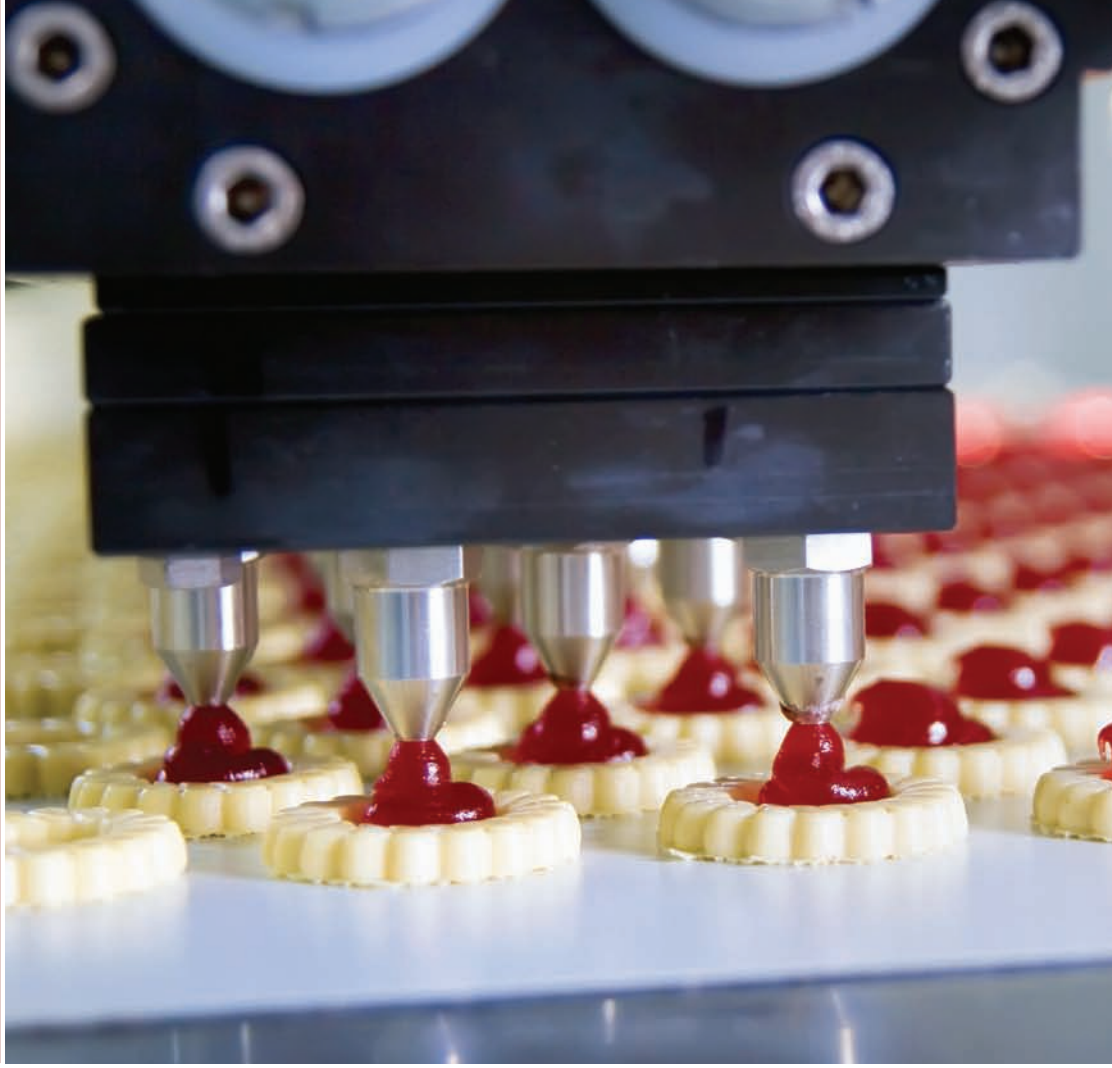
After studying this chapter, you should be able to:

- ➤1 Describe how unit input standards are developed, and explain why standard costing systems are adopted.
- ➤2 Explain the purpose of a standard cost sheet.
- ➤3 Compute and journalize the direct materials and direct labour variances, and explain how they are used for control.
- ➤4 Compute overhead variances three different ways, and explain overhead accounting.
- ➤5 Calculate mix and yield variances for direct materials and direct labour.



CHAPTER 9

Standard Costing: A Functional-Based Control Approach

Budgets help managers in planning and also set standards that are used to control and evaluate managerial performance. In Chapter 8, we saw that budgets can be classified as static or flexible. Static budgets are not very useful for assessing efficiency; their main value is assessing whether or not the targeted level of activity is achieved and, thus, provide some insight concerning managerial effectiveness. Flexible budgets evaluate efficiency by comparing the actual costs and actual revenues with the corresponding budgeted amounts for the *same* level of activity. These flexible budget variances generate important feedback for managers but fail to reveal whether the sources of the variances are attributable to input prices, input quantities, or both.

Developing Unit Input Standards

OBJECTIVE ➤1
Describe how unit input standards are developed, and explain why standard costing systems are adopted.

Although flexible budget variances provide significant information for control, developing standards for input prices and input quantities allows a more detailed understanding of the sources of these variances. By developing standards for the products and services

being offered, managers can compare performance to them. **Price standards** specify how much should be paid for the quantity of the input to be used. **Quantity standards** specify how much of the input should be used per unit of output. The **unit standard cost** is defined as the product of these two standards: Standard price × Standard quantity ($SP \times SQ$).

For example, Peterson Company, a manufacturer of specialty ice creams and frozen yogurts, may decide that 750 grams of yogurt should be used for every litre of frozen yogurt produced (the quantity standard) and that the price to be paid for the yogurt should be $0.12 per 100 grams (the price standard). The standard cost of the yogurt per litre of frozen yogurt is then $0.90 ($0.12 × 7.5). The standard cost of yogurt per litre can be used to predict what the total cost of yogurt should be as the activity level varies; it thus becomes a flexible budget formula. If 20,000 litres of frozen yogurt are produced, the total expected cost of yogurt is $18,000 ($0.90 × 20,000); if 30,000 litres are produced, the total expected cost of yogurt is $27,000 ($0.90 × 30,000). Standard costs, therefore, facilitate budgeting, but the input price and quantity standards will also allow us to obtain a more detailed analysis of the flexible budget variance.

Establishing Standards

Developing standards requires significant input from a variety of sources. Historical experience, engineering studies, and input from operating personnel are three potential sources of quantitative standards. Historical experience should be used with caution because relying on input-output relationships from the past may perpetuate operating inefficiencies. Engineers and operating personnel can provide valuable insights concerning efficient levels of input quantities. Similar comments can be made about input price standards. Price standards are the joint responsibility of operations, purchasing, personnel, and accounting. Operations determine the quality of the inputs required; personnel and purchasing are responsible for acquiring the input quality requested at the lowest price. Market forces, trade unions, and other external forces limit the range of choices for price standards. In setting price standards, purchasing must consider discounts, freight, and quality; personnel must consider payroll taxes, fringe benefits, and qualifications. Accounting is responsible for recording price standards and for preparing reports that compare actual performance to the standard.

Standards are often classified as either *ideal* or *currently attainable*. **Ideal standards** demand maximum efficiency and can be achieved only if everything operates perfectly. No machine breakdowns, slack, or lack of skill (even momentarily) are allowed. **Currently attainable standards** can be achieved under efficient operating conditions. Allowance is made for normal breakdowns, interruptions, less than perfect skill, and so on. These standards are demanding but achievable. One cautionary observation about standards should be made. If standards are too tight and never achievable, workers become frustrated, and performance levels decline. However, challenging but achievable standards can lead to higher performance levels—particularly when the individuals subject to the standards have participated in their creation.

Kaizen Standards

Kaizen standards are continuous improvement standards. They reflect planned improvement and are a type of currently attainable standard. Kaizen standards by their very nature have a cost reduction focus and because of their emphasis on continuous improvement are constantly changing. (They are dynamic standards.) Kaizen standards are discussed in detail in Chapter 14. This chapter focuses on the more traditional standard cost system.

Standards and Activity-Based Costing

Standards also play an important role in activity-based systems. An activity's cost is determined by the amount of resources consumed by each activity. To avoid measuring the amount of resource consumption on an ongoing basis for literally hundreds of activities, standard consumption patterns are identified based on historical experience. The purpose of standards in this case is to facilitate cost assignments. Control is not an issue. Standards used in this sense were discussed in Chapter 6. Activity-based systems also use

standards for control, where control is specifically defined as cost reduction. Activities are classified as either value-added or non-value-added. For each activity, the ideal output is identified and then efforts are made to reduce activity production to this ideal level. This activity-based approach to control is described in Chapter 14.

Usage of Standard Costing Systems

Standard costing systems are widely used. For example, according to one survey, 74 percent of the respondents were using a standard costing system, with the usage emphasis being placed on planning and control.[1] Several reasons for adopting a standard costing system include managing costs, improving planning and control, facilitating decision making, and facilitating product costing.

Cost Management Standard costing allows managers to manage costs by establishing standards that reflect efficient operating conditions. Standards also help managers understand what needs to be done to improve current and future performance. Furthermore, for firms concerned with continuous improvement, kaizen standards are useful aids in achieving significant cost reductions.

Planning and Control Standard costing systems enhance planning and control and improve performance measurement. Unit standards are a fundamental requirement for a flexible budgeting system, which is a key feature of a meaningful planning and control system. Budgetary control systems compare actual costs with budgeted costs by computing variances, the difference between the actual and planned costs for the actual level of activity. By developing unit price and quantity standards, an overall variance can be decomposed into a *price variance* and a *usage* or *efficiency variance*. By performing this decomposition, a manager has more and better information. For example, a manager can tell whether the variance is due to differences between planned prices and actual prices, to differences between planned usage and actual usage, or to both. Thus, in principle, the use of efficiency variances enhances operational control. Additionally, by breaking out the price variance, over which managers have little control, the system provides an improved measure of managerial efficiency.

Decision Making and Product Costing Standard costing systems are useful for decision making and product costing. For example, standard costing systems provide readily available unit cost information that can be used for pricing decisions. This is particularly useful for companies that engage in extensive bidding and for companies that are paid on a cost-plus basis. Standard product costs are determined using quantity and price standards for direct materials, direct labour, and overhead. In contrast, a normal costing system predetermines overhead costs for the purpose of product costing but assigns direct materials and direct labour to products by using actual costs. An actual costing system assigns the actual costs of all three manufacturing inputs to products. Exhibit 9-1 summarizes these three cost assignment approaches.

Exhibit 9-1

Cost Assignment Approaches

	Manufacturing Costs		
	Direct Materials	**Direct Labour**	**Overhead**
Actual costing system	Actual	Actual	Actual
Normal costing system	Actual	Actual	Budgeted
Standard costing system	Standard	Standard	Standard

[1] Norwood Whittle, "Older and Wiser," *Management Accounting* (July/August 2000): 34–36.

Standard costing also simplifies product costing for firms in process industries. For example, if a process-costing system uses standard costing to assign product costs, there is no need to compute a unit cost for each equivalent unit-cost category. A standard unit cost would exist for direct materials, transferred-in materials, and conversion costs categories.[2] Usually, a standard process-costing system will follow the equivalent-unit calculation of the FIFO approach. That is, *current* equivalent units of work are calculated. By calculating current equivalent units of work, current actual production costs can be compared with standard costs (costs allowed for current production) for control purposes.

OBJECTIVE 2
Explain the purpose of a standard cost sheet.

Standard Cost Sheets

Standard costing systems can be used in both manufacturing and service organizations. Both products and services use inputs such as direct materials, direct labour, and overhead. Standard costing simply establishes price and quantity standards for these inputs regardless of whether the inputs are associated with tangible or intangible products. To illustrate standard costing for a service setting, consider a hospital. Hospital costing systems often use a homogeneous work unit called a relative value unit (*RVU*). An *RVU* measures the relative amount of time required to perform a procedure. Although the exact time to perform a particular test is not revealed, the relative time for performing two or more distinct tests has been computed. Thus, a test with an *RVU* of three will take three times as long to perform as a test with an *RVU* of one. Historical standards can be computed by dividing the variable direct labour costs of a hospital department by the number of *RVU*s performed by that department. This standard direct labour cost per *RVU* can then be multiplied by the *RVU*s of a given procedure to obtain the standard direct labour cost for that procedure.[3]

As indicated, standard costs are developed for direct materials, direct labour, and overhead used in producing a product or service. Using these costs, the **standard cost per unit** is computed. The **standard cost sheet** provides the detail underlying the standard unit cost. To illustrate, let us develop a standard cost sheet for a litre of deluxe strawberry frozen yogurt, produced by Peterson Company. The production of the strawberry frozen yogurt begins by creating two different mixtures. The first mixture consists of milk and gelatin. These two ingredients are mixed, heated, and then cooled. The second mixture consists of yogurt, cream, and crushed strawberries. The two mixtures are blended and mixed well. This final mixture is then poured into a one-litre container and frozen. The process is automated. Direct labour is used to operate the equipment and inspect the product for consistency and flavour. The standard cost sheet is given in Exhibit 9-2.

Five materials are used to produce the deluxe strawberry frozen yogurt: yogurt, strawberries, milk, cream, and gelatin. The container in which the yogurt is placed is also classified as a direct material. Direct labour consists of machine operators (who also inspect). Variable overhead, applied using direct labour hours, is made up of three costs: gas (used in cooking), electricity (used to operate the equipment), and water (used for cleaning). Fixed overhead, also applied using direct labour hours, consists of salaries, depreciation, taxes, and insurance. Notice that 1,150 grams of liquids (yogurt, milk, and cream) are used to produce a litre of frozen yogurt. This extra input is needed for two reasons. First, some liquid is lost through evaporation. Second, Peterson wants slightly more than 1,000 grams of frozen yogurt placed in each container to ensure customer satisfaction and to meet government requirements for the government's office of weights and measures.

Exhibit 9-2 reveals other important insights. The standard usage for variable and fixed overhead is tied to the direct labour standards. For variable overhead, the rate is

[2] If you have not read the chapter on process costing (Chapter 5), the discussion on the merits of standard costing will not be as meaningful. However, the point being made is still relevant. Standard costing can produce useful computational savings.

[3] For an interesting description of how historical labour standards can be developed in a hospital setting, see Richard D. McDermott, Kevin D. Stocks, and Joan Ogden, *Code Blue* (Syracuse, Utah: Traemus Books, 2000): 212–221.

Exhibit 9-2

Standard Cost Sheet for Deluxe Strawberry Frozen Yogurt

Description	Standard Price (100 grams)		Standard Usage		Standard Cost	Subtotal
Direct materials:						
Yogurt	$ 0.12	×	750 g	=	$0.90	
Strawberries	0.05	×	400 g	=	0.20	
Milk	0.10	×	300 g	=	0.30	
Cream	0.24	×	100 g	=	0.24	
Gelatin	0.04	×	50 g	=	0.02	
Container	0.06	×	1	=	0.06	
Total direct materials						$1.72
Direct labour:						
Machine operators	16.00	×	0.01 hr	=	$0.16	
Total direct labour						0.16
Overhead:						
Variable overhead	12.00	×	0.01 hr	=	$0.12	
Fixed overhead	40.00	×	0.01 hr	=	0.40	
Total overhead						0.52
Total standard unit cost						$2.40

$12.00 per direct labour hour. Since one litre of frozen yogurt uses 0.01 direct labour hour, the variable overhead cost assigned to a litre is $0.12 ($12.00 × 0.01). For fixed overhead, the rate is $40 per direct labour hour, making the fixed overhead cost per litre $0.40 ($40 × 0.01). Using direct labour hours as the only driver to assign overhead reveals that Peterson uses a traditional, volume-based cost accounting system.

The standard cost sheet reveals the quantity of each input that should be used to produce one unit of output. The unit quantity standards can be used to compute the total amount of inputs allowed for the actual output. This computation is an essential component in computing efficiency variances. A manager should be able to compute the **standard quantity of materials allowed** (*SQ*) and the **standard hours allowed** (*SH*) for the actual output. This computation must be done for every class of direct material and for every class of direct labour. Cornerstone 9-1 shows how and why the standard amounts for actual production are computed.

Variance Analysis for Direct Materials and Direct Labour

OBJECTIVE ➤ 3

Compute and journalize the direct materials and direct labour variances, and explain how they are used for control.

A flexible budget can be used to identify the direct material or direct labour input costs that should have been incurred for the actual level of activity. This planned cost is obtained by multiplying the amount of input allowed for the actual output by the standard unit price. Letting *SP* be the standard unit price of an input and *SQ* the standard quantity of inputs allowed for the actual output, the planned or budgeted input cost is $SP \times SQ$. The actual input cost is $AP \times AQ$, where *AP* is the actual price per unit of the input, and *AQ* is the actual quantity of input used. The **total budget variance** is the difference between the actual cost of the input and its standard cost:

$$\text{Total budget variance} = (AP \times AQ) - (SP \times SQ)$$

The total budget variance measures the difference between the actual cost of direct materials and direct labour and their budgeted costs for the actual level of activity. While it is interesting to know whether or not the actual costs were as planned, the detail of the standard cost card allows managers to determine what aspects of

CORNERSTONE 9-1

The HOW and WHY of Computing Standard Quantities Allowed (*SQ* and *SH*)

Information:

During the first week of April, Peterson Company produced 20,000 litres of deluxe strawberry frozen yogurt. Exhibit 9-2 shows that the unit quantity standard is 750 grams of yogurt per litre and that the unit standard is 0.01 direct labour hour per litre.

Why:

Unit standards must be converted to the standard quantities of inputs allowed for actual production in order to determine how much of each resource is expected to be used. Managers can use the standard quantities allowed in planning (to estimate how much will be required for planned production) or in control (to compare with the actual quantities used).

Required:

1. Calculate the grams of yogurt that should have been used (*SQ*) for the production of 20,000 litres of frozen yogurt.
2. Calculate the hours of direct labour that should have been used (*SH*) for the production of 20,000 litres of frozen yogurt.
3. ***What if*** 22,000 litres of frozen yogurt had actually been produced in the first week of April? Would the standard quantities of yogurt (in grams) and of direct labour hours be higher or lower than the amounts calculated in Requirements 1 and 2? What would the new standard quantities be?

Solution:

1. Yogurt allowed:

$$\begin{aligned} SQ &= \text{Unit quantity standard} \times \text{Actual output} \\ &= 750 \times 20{,}000 \\ &= 15{,}000{,}000 \text{ grams} \end{aligned}$$

2. Operator hours allowed:

$$\begin{aligned} SH &= \text{Unit labour standard} \times \text{Actual output} \\ &= 0.01 \times 20{,}000 \\ &= 200 \text{ direct labour hours} \end{aligned}$$

3. If 22,000 litres were produced instead of 20,000, the standard quantities allowed would be higher, since the production of more frozen yogurt takes more yogurt and more direct labour hours. The *SQ* for yogurt would be 16,500,000 grams (750 × 22,000), and the *SH* for direct labour hours would be 220 hours (0.01 × 22,000).

total cost were different than planned. The next sections discuss the way that the total variances can be decomposed into the price and usage variances for direct materials and the rate and efficiency variances for direct labour.

Calculating the Direct Materials Price Variance and Direct Materials Usage Variance

The total budget variance can be broken down into price and usage variances. **Price (rate) variance** is the difference between the actual and standard unit prices of an input multiplied by the actual quantity of inputs. **Usage (efficiency) variance** is the difference between the actual and standard quantity of inputs multiplied by the

standard unit price of the input. An **unfavourable (U) variance** occurs whenever actual prices or usage of inputs are greater than standard prices or usage. When the opposite occurs, a **favourable (F) variance** is obtained. Every nonzero variance must be tagged as favourable or unfavourable. This lets the manager know the direction of the deviation from standard.

The price and usage variances can be computed using formulas or a graphical, three-pronged approach. The choice is up to the individual; some people find the formulas more meaningful, others appreciate the graphical approach. Both approaches will be illustrated in the Cornerstones. First, we will set up the formulas for the direct materials price and usage variances.

Let:

AP = Actual price per unit
SP = Standard price per unit
AQ = Actual quantity of direct material used in production
SQ = Standard quantity
MPV = Materials price variance
MUV = Materials usage variance

The **direct materials price variance (*MPV*)** is the difference between what was actually paid for direct materials and what would have been paid for the actual quantity bought if it had been bought at the standard price. Thus, the materials price variance is:

$$MPV = (AP \times AQ) - (SP \times AQ)$$

or, factoring, we have:

$$MPV = (AP - SP)AQ$$

The *MPV* is calculated as the difference between actual and standard prices multiplied by the actual quantity. If the actual price is greater than standard, the *MPV* is U (unfavourable). If the actual price is less than the standard price, the *MPV* is F (favourable).

The **direct materials usage variance (*MUV*)** is the difference between the amount of materials actually used and what should have been used for the actual quantity of units produced multiplied by the standard price. Thus, the materials usage variance is:

$$MUV = (SP \times AQ) - (SP \times SQ)$$

or, factoring, we have:

$$MUV = (AQ - SQ)SP$$

The *MUV* is quickly calculated as the difference between actual and standard amounts of direct materials multiplied by the standard price. If the actual quantity is greater than standard, the *MUV* is U (unfavourable). If the actual quantity is less than the standard quantity, the *MUV* is F (favourable). Cornerstone 9-2 shows the how and why of calculating the direct materials price and usage variances.

Cornerstone 9-2 calculated only the *MPV* and *MUV* for one input, yogurt, in order to simplify the example. In actuality, Peterson would calculate these two variances for each type of direct material used.

Timing of the Price Variance Computation The direct materials price variance can be computed at one of two points: (1) when the direct materials are issued for use in production or (2) when they are purchased. Computing the price variance at the point of purchase is preferable. It is better to have information on variances earlier rather than later. The more timely the information, the more likely proper managerial action can be taken. Old information is often useless information. Direct materials may sit in inventory for weeks or months before they are needed in production. By the time the direct materials price variance is computed, signalling a problem, it may be too late to take corrective action. Or, even if corrective action is still possible, the delay may cost the company thousands of dollars.

If the direct materials price variance is computed at the point of purchase, then *AQ* needs to be redefined as the actual quantity of direct materials *purchased*, rather

CORNERSTONE 9-2

The HOW and WHY of Computing the Direct Materials Price Variance (*MPV*) and Direct Materials Usage Variance (*MUV*)

Information:

Peterson Company provided the following information for the production of deluxe strawberry frozen yogurt during the month of April:

Actual production: 30,000 litres

Actual yogurt usage: 21,500,000 grams (no beginning or ending yogurt inventory)

Actual price paid per 100 grams of yogurt: $0.15

Recall from Exhibit 9-2 that the unit quantity standard is 750 grams of yogurt per litre, the standard price of yogurt is $0.12 per 100 grams, and the direct labour standard is 0.01 direct labour hour per litre.

Why:

The total direct materials variance can be due to a difference between actual and planned prices for the materials, or between actual quantity used versus the standard quantity, or a combination of both. Computing the direct materials price variance (*MPV*) and the direct materials usage variance (*MUV*) tells managers whether the difference is due to price or usage or both. Any variance can be investigated further to see if there is a problem.

Required:

1. Calculate the grams of yogurt that should have been used (*SQ*) for the actual production of frozen yogurt for the month of April.
2. Calculate the direct materials price variance (*MPV*) and the direct materials usage variance (*MUV*) for April using the formula approach.
3. Calculate the direct materials price variance (*MPV*) and the direct materials usage variance (*MUV*) for April using the graphical approach.
4. Calculate the total direct materials variance for yogurt for April.
5. ***What if*** the actual price paid in April was $0.12 per 100 grams of yogurt? What impact would that have had on the materials price variance (*MPV*)? On the materials usage variance (*MUV*)?

Solution:

1. Yogurt allowed:

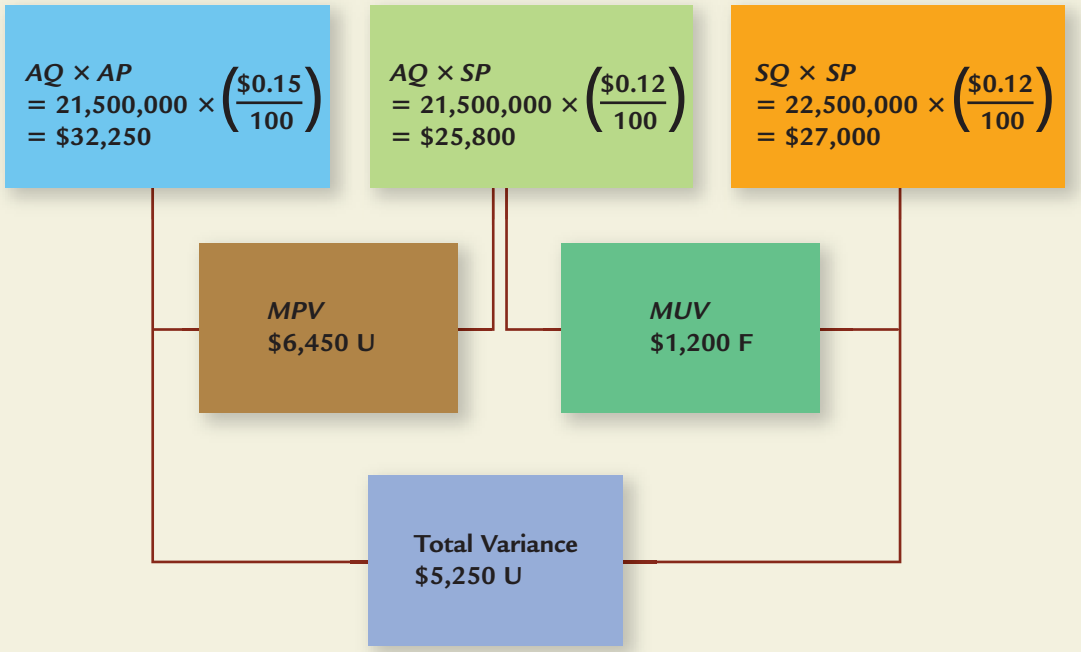
$$\begin{aligned} SQ &= \text{Unit quantity standard} \times \text{Actual output} \\ &= 750 \times 30{,}000 \\ &= 22{,}500{,}000 \text{ grams} \end{aligned}$$

2. Formulas (recommended approach for materials variances because materials purchases may differ from materials used in production):

$$\begin{aligned} \text{Materials price variance } (MPV) &= (AP - SP)AQ \\ &= (\$0.15 - \$0.12)\frac{21{,}500{,}000}{100} \\ &= \$0.03 \times 215{,}000 = \$6{,}450 \text{ U} \\ \text{Materials usage variance } (MUV) &= (AQ - SQ)SP \\ &= \left[\frac{(21{,}500{,}000 - 22{,}500{,}000)}{100}\right]\$0.12 \\ &= 10{,}000 \times \$0.12 = \$1{,}200 \text{ F} \end{aligned}$$

3.

CORNERSTONE 9-2 *(continued)*



4. Total direct materials variance $= (AP \times AQ) - (SP \times SQ) = MPV + MUV$

$$= \left(\left(\frac{\$0.15}{100}\right) \times 21{,}500{,}000\right) - \left(\frac{\$0.12}{100} \times 22{,}500{,}000\right)$$

$$= \$32{,}250 - \$27{,}000$$

$$= \$5{,}250 \text{ U}$$

Notice that $5,250 U is also equal to the sum of the *MPV* and *MUV*.

$$(MPV + MUV) = \$6{,}450 \text{ U} + \$1{,}200 \text{ F}$$

$$= \$5{,}250 \text{ U}$$

5. If the actual price was $0.12 per 100 grams, it would be exactly equal to the standard price and the materials price variance would be zero. There would be no impact on the materials usage variance because the actual price is not used in that computation.

than actual direct materials *used*. Since the direct materials purchased may differ from the direct materials used, the overall direct materials budget variance is not necessarily the sum of the direct materials price variance and the direct materials usage variance. When the direct materials purchased are all used in production for the period in which the variances are calculated, the two variances will equal the total budget variance. If the direct materials price variance is calculated at the time of purchase, then the three-pronged approach must be adapted by using two definitions for AQ. The first will be the actual quantity purchased, which will be used to calculate the price variance; the second AQ will be the actual quantity used, which will be used to calculate the quantity variance.

Exhibit 9-3

Standard Bill of Materials

Product: Litres of Deluxe Strawberry Frozen Yogurt		Output: 30,000 Litres
Direct Material	**Unit Standard**	**Total Requirements**
Yogurt	750 g	22,500,000 grams
Strawberries	400 g	12,000,000 grams
Milk	300 g	9,000,000 grams
Cream	100 g	3,000,000 grams
Gelatin	50 g	1,500,000 grams
Container	1 container	30,000 containers

The direct materials price variance can give managers an early warning of price increases that will impact the production and sale of product. For example, a close watch on the price of hops (responsible for the characteristic bitterness and aroma of beer) allowed beer makers to anticipate the impact of escalating prices on the sale of the product. Some brewers used the information to find substitute hops varieties. Others investigated long-term contracts to lock in a stable price. Still others began instituting gradual price increases of the final product.[4]

Timing of the Direct Materials Usage Variance Computation The direct materials usage variance should be computed as direct materials are issued for production. To facilitate this process, many companies use three forms: a standard bill of materials, colour-coded excessive usage forms, and colour-coded returned-materials forms. The **standard bill of materials** identifies the quantity of direct materials that should be used to produce a predetermined quantity of output. A standard bill of materials for Peterson Company is illustrated in Exhibit 9-3.

The standard bill of materials acts as a materials requisition form. The production manager presents this form to the materials manager and receives the standard quantity allowed for the indicated output. If the production manager has to requisition more direct materials later, the excessive usage form is used. This form, different in colour from the standard bill of materials, provides immediate feedback to the production manager that excess direct materials are being used. If, on the other hand, fewer direct materials are used than the standard requires, the production manager can return the leftover direct materials, along with the returned-materials form. This form also provides immediate feedback.

Accounting for Direct Materials Price and Usage Variances

As a general rule, in a *standard costing system*, *all inventories are carried at standard*. Actual costs are never entered into an inventory account. Following this general rule means that the direct materials price variance is computed at the point of purchase. In recording variances, unfavourable variances are always debits, and favourable variances are always credits. The general form of the journal entry associated with the purchase of direct materials for a standard costing system follows. This entry assumes an unfavourable *MPV* and that *AQ* is defined as direct materials purchased.

Materials	$SP \times AQ$	
Direct Materials Price Variance	$(AP - SP)AQ$	
Accounts Payable		$AP \times AQ$

[4] David Kesmodel and Janet Adamy. "Why Price Increases Are Brewing for Craft Beers," *The Wall Street Journal* (October 5, 2007): B1.

For the Peterson Company example, the entry pertaining to the acquisition of yogurt would be:

Materials	25,800	
Direct Materials Price Variance	6,450	
Accounts Payable		32,250

The direct materials usage variance is recognized when direct materials are issued. The standard cost of the direct materials issued is assigned to Work in Process. The general form for the entry to record the issuance and usage of direct materials, assuming a favourable *MUV*, is as follows:

Work in Process	$SQ \times SP$	
Direct Materials Usage Variance		$(AQ - SQ)SP$
Materials		$AQ \times SP$

The entry to record Peterson's usage of yogurt during April is as follows:

Work in Process	27,000	
Direct Materials Usage Variance		1,200
Materials		25,800

Calculating Direct Labour Variances The rate (price) and efficiency (usage) variances for direct labour can be calculated using either the graphical, three-pronged approach or a formula approach. First, we will present the formulas for the direct labour rate variance and the direct labour efficiency variance. Then, Cornerstone 9-3 shows the how and why of calculating these variances using the formula and graphical approaches.

The HOW and WHY of Computing the Direct Labour Rate Variance (*LRV*) and Direct Labour Efficiency Variance (*LEV*)

CORNERSTONE 9-3

Information:

Peterson Company provided the following information for the production of deluxe strawberry frozen yogurt during the month of April:

Actual production: 30,000 litres

Actual direct labour hours worked: 325 hours

Actual rate paid per hour to direct labour: $15.90

Recall from Exhibit 9-2 that the unit quantity standard is 0.01 hour of direct labour per litre and that the standard wage rate is $16 per direct labour hour.

Why:

The total direct labour variance can be due to a difference between actual and planned wage rates for direct labour, or between actual hours worked versus the standard hours allowed for actual production, or a combination of both. Computing the direct labour rate variance (*LRV*) and the direct labour efficiency variance (*LEV*) tells managers whether the difference is due to wage rates or hours worked or both. Any variance can be investigated further to see if there is a problem.

Required:

1. Calculate the direct labour hours that should have been worked (*SH*) for the actual production of frozen yogurt for the month of April.
2. Calculate the direct labour rate variance (*LRV*) and the direct labour efficiency variance (*LEV*) for April using the formula approach.
3. Calculate the direct labour rate variance (*LRV*) and the direct labour efficiency variance (*LEV*) for April using the graphical approach.
4. Calculate the total direct labour variance for yogurt for April.

CORNERSTONE 9-3 *(continued)*

5. ***What if*** only 295 hours were actually worked in April? What impact would that have had on the direct labour rate variance (*LRV*)? On the direct labour efficiency variance (*LEV*)?

Solution:

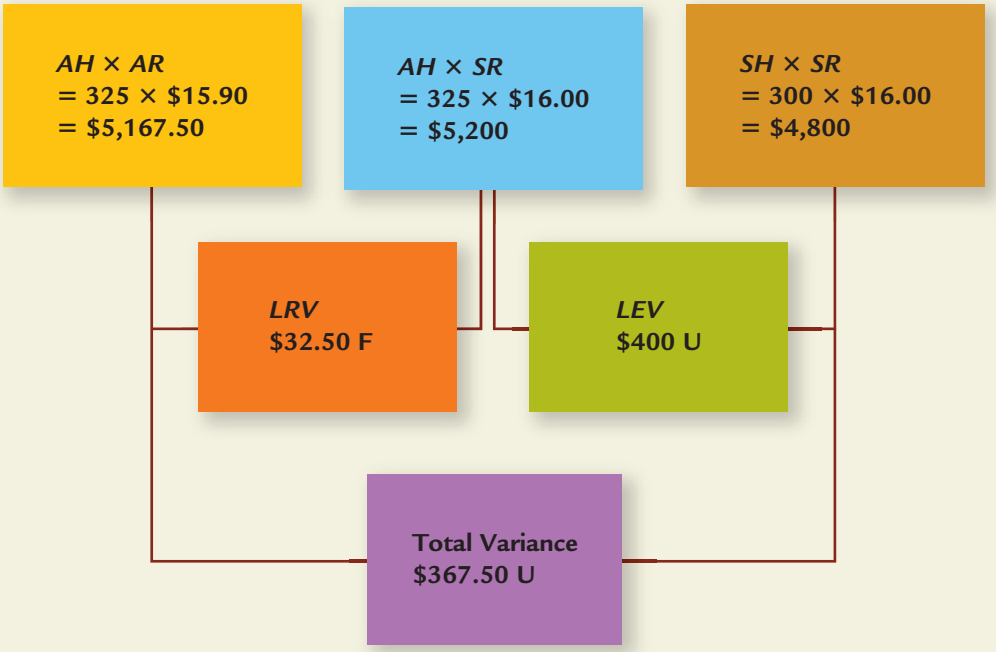
1. Direct labour hours at standard for actual production:

$$SH = \text{Unit quantity standard} \times \text{Actual output}$$
$$= 0.01 \times 30{,}000$$
$$= 300 \text{ hours}$$

2. Formulas:

$$\text{Labour rate variance } (LRV) = (AR - SR)AH = (\$15.90 - \$16.00)325$$
$$= \$0.10 \times 325 = \$32.50 \text{ F}$$
$$\text{Labour efficiency variance } (LEV) = (AH - SH)SR = (325 - 300)\$16.00$$
$$= (25 \times \$16.00) = \$400 \text{ U}$$

3.



4. $\text{Total direct labour variance} = (AR \times AH) - (SR \times SH) = LRV + LEV$
$= (\$15.90 \times 325) - (\$16.00 \times 300)$
$= \$5{,}167.50 - \$4{,}800$
$= \$367.50 \text{ U}$

Notice that $367.50 U is also equal to the sum of the *LRV* and *LEV*.

$(LRV + LEV) = \$32.50 \text{ F} + \$400 \text{ U}$
$= \$367.50 \text{ U}$

5. If 295 hours had been worked in April, the direct labour rate variance would be $29.50 F[($15.90 − $16.00)295]. The direct labour efficiency variance would be favourable since 295 hours is less than the standard direct labour hours allowed for actual production. The *LEV* in that case would be $80 F [(295 − 300)$16.00].

Direct Labour Rate and Efficiency Variances: Formula Approach The **direct labour rate variance (*LRV*)** computes the difference between what was paid to direct labourers and what should have been paid:

$$LRV = (AR \times AH) - (SR \times AH)$$

or, factoring, we have:

$$LRV = (AR - SR)AH$$

where

AR = Actual hourly wage rate
SR = Standard hourly wage rate
AH = Actual direct labour hours used

The **direct labour efficiency variance (*LEV*)** measures the difference between the direct labour hours that were actually used and the direct labour hours that should have been used:

$$LEV = (AH \times SR) - (SH \times SR)$$

or, factoring, we have:

$$LEV = (AH - SH)SR$$

where

AH = Actual direct labour hours used
SH = Standard direct labour hours that should have been used
SR = Standard hourly wage rate

Accounting for the Direct Labour Rate and Efficiency Variances The journal entries to record the direct labour rate and efficiency variance are made simultaneously. The general form of this journal entry follows. (It assumes a favourable direct labour rate variance and an unfavourable direct labour efficiency variance.)

Work in Process	$SH \times SR$	
Direct Labour Efficiency Variance	$(AH - SH)SR$	
Direct Labour Rate Variance		$(AR - SR)AH$
Wages Payable		$AH \times AR$

Notice that only standard hours and standard rates are used to assign direct labour costs to Work in Process. Actual prices and quantities are not used. This emphasizes the principle that all inventories are carried at standard.

The journal entry for Peterson's use of direct labour during April follows. The direct labour efficiency variance is unfavourable, so it is debited. The direct labour rate variance is favourable so it is credited.

Work in Process	4,800.00	
Direct Labour Efficiency Variance	400.00	
Direct Labour Rate Variance		32.50
Wages Payable		5,167.50

Investigating Direct Materials and Labour Variances

Rarely will actual performance exactly meet the established standards, nor does management expect it to do so. Random variations around the standard are expected. Because of this, management should have in mind an acceptable range of performance. When variances are within this range, they are assumed to be caused

by random factors. When a variance falls outside this range, the deviation is likely to be caused by nonrandom factors, either factors that managers can control or factors they cannot control. In the noncontrollable case, managers need to revise the standard. For the controllable case, an investigation should be undertaken only if the expected benefits of investigating and correcting the problem are greater than the expected costs. In making this assessment, a manager must consider whether a variance will recur. If so, the process may be permanently out of control, meaning that periodic savings may be achieved if corrective action is taken. For example, consider Peterson's unfavourable materials price variance. Assume that investigation reveals that the unfavourable direct materials price variance was the result of purchasing higher-quality strawberries than needed. In this case, a new purchasing agent mistakenly bought large, perfectly shaped strawberries suitable for decoration, rather than smaller strawberries suitable for crushing and mixing into the frozen yogurt mix. The agent was trained in the difference between grades of strawberries, and no further problems were noticed.

Because it is difficult to assess the costs and benefits of variance analysis on a case-by-case basis, many firms adopt the general guideline of investigating variances only if they fall outside an acceptable range. The acceptable range is the standard, plus or minus an allowable deviation. The top and bottom measures of the allowable range are called the **control limits**. The *upper control limit* is the standard plus the allowable deviation, and the *lower control limit* is the standard minus the allowable deviation. Current practice sets the control limits subjectively: based on past experience, intuition, and judgment, management determines the allowable deviation from standard.[5]

The control limits are usually expressed both as a percentage of the standard and as an absolute dollar amount. For example, the allowable deviation may be expressed as the lesser of 10 percent of the standard amount or $10,000. In other words, management will not accept a deviation of more than $10,000 even if that deviation is less than 10 percent of the standard. Alternatively, even if the dollar amount is less than $10,000, an investigation is required if the deviation is more than 10 percent of the standard amount. Formal statistical procedures can also be used to set the control limits. In this way, less subjectivity is involved and a manager can assess the likelihood of the variance being caused by random factors. The use of such formal procedures has gained little acceptance. Cornerstone 9-4 shows how and why control limits can be used to guide variance investigation decisions.

Responsibility for the Direct Materials Variances The responsibility for controlling the direct materials price variance is usually the purchasing agent's. Admittedly, the price of direct materials is largely beyond his or her control; however, the price variance can be influenced by such factors as quality, quantity discounts, distance of the source from the plant, and so on. These factors are often under the control of the agent. The production manager is generally responsible for direct materials usage. Minimizing scrap, waste, and rework are all ways in which the manager can ensure that the standard is met. However, at times, the cause of the variance is attributable to others outside the production area. For example, the purchase of lower-quality direct materials may produce bad output. In this case, responsibility would be assigned to purchasing rather than production.

Using the price variance to evaluate the performance of purchasing has some limitations. Emphasis on meeting or beating the standard can produce some undesirable outcomes. For example, if the purchasing agent feels pressured to produce favourable variances, he or she may purchase lower-quality direct materials or acquire too much inventory in order to take advantage of quantity discounts. As with the price variance, applying the usage variance to evaluate performance can lead to undesirable

[5] Bruce R. Gaumnitz and Felix P. Kollaritsch, "Manufacturing Variances: Current Practices and Trends," *Journal of Cost Management* (Spring 1991): 58–64. In this article, the authors report that about 45–47 percent of firms use dollar or percentage control limits. Most of the remaining firms use judgment rather than any formal identification of limits.

The HOW and WHY of Using Control Limits to Determine When to Investigate a Variance

CORNERSTONE 9-4

Information:

Standard cost: $100,000; allowable deviation is ± $10,000. Actual costs for the past six months are as follows:

June	$ 97,500	September	$102,500
July	105,000	October	107,500
August	95,000	November	112,500

Why:

Because actual costs rarely are exactly equal to standard, variances occur frequently. Investigating variances is costly. Therefore, it is useful for managers to have a rule that tells them when variances should be investigated, and when they are likely of little consequence.

Required:

1. Calculate the variance from standard for each month. Which months should be investigated?
2. ***What if*** the company uses a two-part rule for investigating variances? The allowable deviation is the lesser of 5 percent of the standard amount or $10,000. Now which months should be investigated?

Solution:

1. Variance for June = $100,000 – $97,500 = $2,500 F

   Variance for July = $100,000 – $105,000 = $5,000 U

   Variance for August = $100,000 – $95,000 = $5,000 F

   Variance for September = $100,000 – $102,500 = $2,500 U

   Variance for October = $100,000 – $107,500 = $7,500 U

   Variance for November = $100,000 – $112,500 = $12,500 U

   Only November should be investigated, as its variance is greater than $10,000 from standard.

2. 5% of standard cost = 0.05 × $100,000 = $5,000

   As before, November is investigated because its variance is greater than $10,000. However, now July, August, and October will also be investigated since their variances are equal to or greater than 5 percent of standard.

behaviour. For example, a production manager who feels pressure to produce a favourable variance might allow a defective unit to be transferred to finished goods. While this avoids the problem of wasted direct materials, it may create customer-relations problems once a customer gets stuck with the bad product.

Responsibility for the Direct Labour Variances Direct labour rates are largely determined by such external forces as labour markets and union contracts. When direct labour rate variances occur, they often do so because an average wage rate is used for the rate standard or because more skilled and more highly paid labourers are used for less skilled tasks. Wage rates for a particular direct labour activity often differ among workers because of differing levels of seniority. Rather than selecting direct labour rate standards reflecting those different levels, an average wage rate is often used. As the seniority mix changes, the average rate changes, giving rise to a direct labour rate variance. This calls for a new standard to reflect

the new seniority mix. Controllability is not assignable for this cause of a direct labour rate variance.

However, the *use* of direct labour is controllable by the production manager. The use of more skilled workers to perform less skilled tasks (or vice versa) is a decision that a production manager consciously makes. For this reason, responsibility for the direct labour rate variance is generally assigned to the individuals who decide how direct labour will be used. The same is true of the direct labour efficiency variance. However, as is true of all variances, once the cause is discovered, responsibility may be assigned elsewhere. For example, frequent breakdowns of machinery may cause interruptions and nonproductive use of direct labour. But the responsibility for these breakdowns may be faulty maintenance. If so, the maintenance manager should be charged with the unfavourable direct labour efficiency variance.

Production managers may be tempted to engage in dysfunctional behaviour if too much emphasis is placed on the direct labour variances. For example, to avoid losing hours and using additional hours because of possible rework, a production manager could deliberately transfer defective units to finished goods.

Disposition of Direct Materials and Direct Labour Variances

Most companies dispose of variances at the end of the year by either closing them to Cost of Goods Sold or prorating them among Work in Process, Cost of Goods Sold, and Finished Goods. If the variances are immaterial, then the most expedient disposition is simply to assign them to Cost of Goods Sold. In that case, a debit balance in a variance account (indicating an overall unfavourable variance) would require an equal amount credited to that account (to bring its ending balance to zero) and an offsetting debit to Cost of Goods Sold. This debit to Cost of Goods Sold will increase the total cost, which makes sense since originally Cost of Goods Sold is carried at standard cost, but an unfavourable variance means that actual cost is greater than standard. Therefore, Cost of Goods Sold must be increased at the end of the year to reflect the higher actual cost. Of course, favourable variances would be credited to Cost of Goods Sold to bring the standard cost down to the lower actual cost.

If the variances are considered material, then the proration option is usually exercised. This option is driven by GAAP requirements that inventories and Cost of Goods Sold be reported at actual costs. Yet, if variances are measures of inefficiency, it seems difficult to justify carrying costs of inefficiency as assets. It seems more logical to write off the costs of inefficiency as a cost of the period. When proration is done, the direct materials and direct labour variances can be assigned in proportion to the total prime costs in Work in Process, Cost of Goods Sold, and Finished Goods. Cornerstone 9-5 shows how to close out the variance accounts at the end of the year and explains why this is done.

Other proration variations are possible. For example, direct materials variances could be assigned in proportion to the total direct materials cost in each account, and the direct labour variances could be assigned in proportion to the total direct labour costs. Some even argue that finer assignments of the variances may be needed. The direct materials price variance, for example, could be assigned to the *MUV*, materials inventory, work-in-process, finished goods, and cost of goods sold accounts (with the other variances assigned only to the usual three inventory accounts).

OBJECTIVE 4

Compute overhead variances three different ways, and explain overhead accounting.

Variance Analysis for Overhead Costs

For direct materials and direct labour, total variances are broken down into price and efficiency variances. The total overhead variance—the difference between applied and actual overhead—is also broken down into component variances. The number of component variances computed depends on the method of variance

The HOW and WHY of Closing the Balances in the Variance Accounts at the End of the Year

CORNERSTONE 9-5

Information:

Peterson Company has the following balances in its direct materials and direct labour variance accounts at year-end:

	Debit	Credit
Direct Materials Price Variance	$45,600	
Direct Materials Usage Variance	5,800	
Direct Labour Rate Variance	4,350	
Direct Labour Efficiency Variance		$61,250

Unadjusted Cost of Goods Sold equals $982,140, unadjusted Work in Process equals $205,700, and unadjusted Finished Goods equals $143,000.

Why:

Companies may carry costs at standard throughout the year, but must restate costs and inventories at the end of the year to actual cost. Therefore, variance accounts must be closed out and their balances applied to Cost of Goods Sold (if immaterial) or prorated among Cost of Goods Sold, Work in Process, and Finished Goods.

Required:

1. Assume that the ending balances in the variance accounts are immaterial and prepare the journal entries to close them to Cost of Goods Sold. What is the adjusted balance in Cost of Goods Sold after closing out the variances?
2. ***What if*** the ending balances in the variance accounts are considered material? The prime cost in Cost of Goods Sold is $767,520, the prime cost in Work in Process is $161,200, and the prime cost in Finished Goods is $111,280. Prorate the variances among the three accounts and prepare the journal entry to close them out. What are the adjusted balances in Work in Process, Finished Goods, and Cost of Goods Sold after closing out the variances?

Solution:

1.

Direct Labour Efficiency Variance	61,250	
Cost of Goods Sold		61,250
Cost of Goods Sold	55,750	
Direct Materials Price Variance		45,600
Direct Materials Usage Variance		5,800
Direct Labour Rate Variance		4,350

$$\text{Adjusted Cost of Goods Sold} = \$982{,}140 + \$45{,}600 + \$5{,}800 + \$4{,}350 - \$61{,}250 = \$976{,}640$$

2.

	Prime Costs	Percentage of Total
Work in Process	$ 161,200	15.5%
Finished Goods	111,280	10.7
Cost of Goods Sold	767,520	73.8
Total	$1,040,000	100.0%

$$\text{Total variance} = \$45{,}600 + \$5{,}800 + \$4{,}350 - \$61{,}250 = \$5{,}500\ \text{F}$$

CORNERSTONE 9-5 (continued)

Direct Labour Efficiency Variance	61,250.00	
Work in Process (0.155 × $61,250)		9,493.75
Finished Goods (0.107 × $61,250)		6,553.75
Cost of Goods Sold (0.738 × $61,250)		45,202.50
Work in Process (0.155 × $55,750)	8,641.25	
Finished Goods (0.107 × $55,750)	5,965.25	
Cost of Goods Sold (0.738 × $55,750)	41,143.50	
Direct Materials Price Variance		45,600.00
Direct Materials Usage Variance		5,800.00
Direct Labour Rate Variance		4,350.00

$$\text{Work in Process} = \$205{,}700 - (0.155 \times \$5{,}500) = \$205{,}700 - \$852.50 = \$204{,}847.50$$

$$\text{Finished Goods} = \$143{,}000 - (0.107 \times \$5{,}500) = \$143{,}000 - \$588.50 = \$142{,}411.50$$

$$\text{Cost of Goods Sold} = \$982{,}140 - (0.738 \times \$5{,}500) = \$982{,}140 - \$4{,}059 = \$978{,}081$$

analysis used. Common methods are the two-, three-, and four-variance methods. The four-variance method provides the most detail, and its component variances can be combined to form the variances for the two- and three-variance methods, which are described later.

In analyzing overhead variances, a traditional approach is assumed. Standard overhead rates are computed in basically the same way that was described in Chapter 6. Traditional overhead rate computations rely on unit-level drivers such as direct labour hours and machine hours. The overhead analysis in this chapter assumes that direct labour hours is the only driver used to assign overhead costs to products. Thus, when we speak of variable and fixed overhead, we are assuming that it is fixed or variable with respect to direct labour hours, a unit-level driver. In Chapter 14, variance analysis is extended to a more general setting where both unit- and non-unit-level drivers are allowed.

Four-Variance Method for Calculating Overhead Variances

The four-variance method calculates two variances for variable overhead and two variances for fixed overhead. We first divide overhead into categories: variable and fixed. Next, we look at component variances for each category. The total variable overhead variance is divided into two components: the variable overhead spending variance and the variable overhead efficiency variance. Similarly, the total fixed overhead variance is divided into two components: the fixed overhead spending variance and the fixed overhead volume variance.

Cornerstone 9-6 shows the how and why of calculating the total variable overhead variance. To illustrate the variable overhead variances, we will continue to use the Peterson Company example. Variances will be constructed for the month of May.

As we see in Cornerstone 9-6, Peterson Company has a $1,720 U total variable overhead variance. In other words, the actual spending on variable overhead is $1,720 more than the amount of variable overhead assigned to production at standard. Why did this occur? We gain more insight into this question by dividing the total variable overhead variance into the variable overhead spending variance and the variable overhead efficiency variance.

The HOW and WHY of Calculating the Total Variable Overhead Variance

CORNERSTONE 9-6

Information:

Peterson Company provided the following information for the month of May:

Variable overhead rate (standard)	$12.00	per direct labour hour[a]
Actual variable overhead costs	$16,120	
Actual hours worked	1,300	
Litres of deluxe strawberry frozen yogurt produced	120,000	
Hours allowed for actual production	1,200[b]	
Applied variable overhead	$14,400[c]	

[a] See Exhibit 9-2 for the standard cost card.
[b] 0.01 direct labour hour at standard × 120,000 actual litres produced (See Exhibit 9-2 for unit standards and prices.)
[c] $12.00 × 1,200 (Overhead is applied using standard hours allowed.)

Why:

The total variable overhead variance shows the difference between actual overhead and the amount expected given the actual level of production. Managers can see whether there is a difference and begin to understand reasons for it.

Required:

1. Calculate the total variable overhead variance.
2. ***What if*** actual production had been 110,000 litres? How would that affect the total variable overhead variance?

Solution:

1. Total variable overhead variance
   = Actual variable overhead – (Variable overhead rate × Standard hours for actual production)
   = $16,120 – ($12 × 1,200) = $16,120 – $14,400
   = $1,720 U
2. If production had been only 110,000 litres, fewer hours would have been allowed at standard and the flexible budget amount for variable overhead would be smaller. Thus, the total variable overhead variance would be a larger unfavourable variance.

Calculating the Variable Overhead Spending Variance and Variable Overhead Efficiency Variance

The **variable overhead spending variance** measures the aggregate effect of differences in the actual variable overhead rate (*AVOR*) and the standard variable overhead rate (*SVOR*). The actual variable overhead rate is simply actual variable overhead divided by actual hours. For example, if actual variable overhead is $3,640 and actual hours worked are 1,400, this rate is $2.60 ($3,640/1,400 direct labour hours). The formula for computing the variable overhead spending variance is as follows:

$$\begin{aligned}\text{Variable overhead spending variance} &= (AVOR \times AH) - (SVOR \times AH)\\ &= (AVOR - SVOR)AH\end{aligned}$$

Variable overhead is assumed to vary as the production volume changes. Thus, variable overhead changes in proportion to changes in the direct labour hours used.

The **variable overhead efficiency variance** measures the change in variable overhead consumption that occurs because of efficient (or inefficient) use of direct labour. The efficiency variance is computed using the following formula:

$$\begin{aligned}\text{Variable overhead efficiency variance} &= (SVOR \times AH) - (SVOR \times SH)\\ &= (AH - SH)SVOR\end{aligned}$$

Cornerstone 9-7 shows the how and why of calculating the variable overhead spending and efficiency variances. It uses both the formula approach explained above and the three-pronged graphical approach.

CORNERSTONE 9-7

The HOW and WHY of Computing the Variable Overhead Spending Variance and the Variable Overhead Efficiency Variance

Information:

Peterson Company provided the following information for the month of May:

Variable overhead rate (standard)	$12.00 per direct labour hour[a]
Actual variable overhead costs	$16,120
Actual hours worked	1,300
Litres of deluxe strawberry frozen yogurt produced	120,000
Hours allowed for actual production	1,200[b]
Applied variable overhead	$14,400[c]

[a] See Exhibit 9-2 for the standard cost card.
[b] 0.01 direct labour hour at standard × 120,000 actual litres produced (See Exhibit 9-2 for unit standards and prices.)
[c] $12.00 × 1,200 (Overhead is applied using standard hours allowed.)

Why:

The total variable overhead variance is broken into the variable overhead spending and efficiency variances. The spending variance shows the difference between the actual variable overhead rate and the standard variable overhead rate. The variable overhead efficiency variance shows the impact of a difference between actual hours worked and the standard hours that should have been worked on the variable overhead. These variances indicate where managers could begin to investigate overhead variances.

Required:

1. Calculate the variable overhead spending variance using the formula approach.
2. Calculate the variable overhead efficiency variance using the formula approach.
3. Calculate the variable overhead spending variance and variable overhead efficiency variance using the three-pronged graphical approach.
4. ***What if*** only 1,190 direct labour hours were actually worked in May? What impact would that have had on the variable overhead spending variance? On the variable overhead efficiency variance?

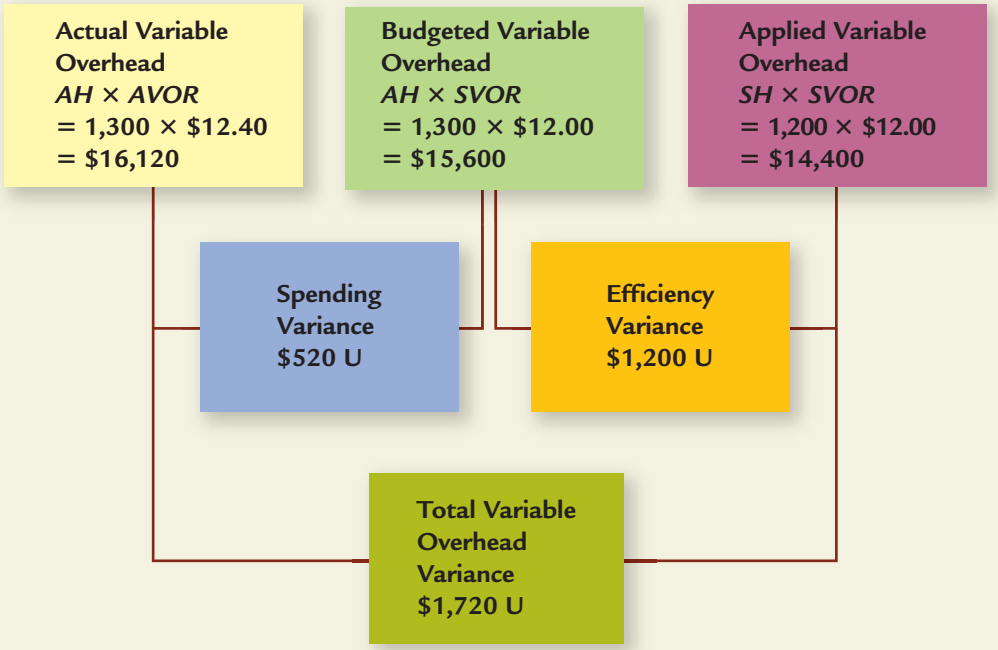
Solution:

1. $$\begin{aligned}\text{Variable overhead spending variance} &= (AVOR - SVOR)AH\\ &= [(\$16{,}120/1{,}300) - \$12.00]1{,}300\\ &= (\$12.40 - \$12.00) \times 1{,}300 = \$520\ \text{U}\end{aligned}$$

CORNERSTONE 9-7 *(continued)*

2. Variable overhead efficiency variance $= (AH - SH)SVOR$
$= (1{,}300 - 1{,}200)\$12 = \$1{,}200$ U

3.



4. If 1,190 direct labour hours had been worked in May, the variable overhead spending variance would be larger (more unfavourable). However, the variable overhead efficiency variance would be favourable since 1,190 hours is less than the standard direct labour hours allowed for actual production.

Interpreting the Variable Overhead Variances

The variable overhead spending variance and the variable overhead efficiency variance give managers information they can use in controlling costs.

Interpreting the Variable Overhead Spending Variance The variable overhead spending variance is similar to the price variances of direct materials and direct labour, although there are some conceptual differences. Variable overhead is not a homogeneous input—it is made up of a large number of individual items such as indirect materials, indirect labour, electricity, maintenance, and so on. The standard variable overhead rate represents the weighted cost per direct labour hour that should be incurred for all variable overhead items. The difference between what should have been spent per hour and what actually was spent per hour is a type of price variance.

A variable overhead spending variance can arise because prices for individual variable overhead items have increased or decreased. Assume, for the moment, that the price changes of individual overhead items are the only cause of the spending variance. If the spending variance is unfavourable, then price increases for individual variable overhead items are the cause; if the spending variance is favourable, then price decreases dominate.

If the only source of the variable overhead spending variance were price changes, then it would be completely analogous to the price variances of direct materials and direct labour. Unfortunately, the spending variance also is affected by how efficiently overhead is used. Waste or inefficiency in the use of variable overhead increases the actual variable overhead cost. This increased cost, in turn, is reflected in an increased actual variable overhead rate. Thus, even if the actual prices of the individual overhead items were equal to the budgeted or standard prices, an unfavourable variable overhead spending variance could still take place. Similarly, efficiency can decrease the actual variable overhead cost and decrease the actual variable overhead rate. Efficient use of variable overhead items contributes to a favourable spending variance. If the waste effect dominates, then the net contribution will be unfavourable; if efficiency dominates, then the net contribution is favourable. Thus, the variable overhead spending variance is the result of both price and efficiency.

Many variable overhead items are affected by several responsibility centres. For example, utilities are a joint cost. Assigning the cost to a specific area of responsibility requires that cost be traced—not allocated—to the area. To the extent that consumption of variable overhead can be traced to a responsibility centre, responsibility can be assigned. Consumption of indirect materials is an example of a traceable variable overhead cost.

Controllability is a prerequisite for assigning responsibility. Price changes of variable overhead items are essentially beyond the control of supervisors. If price changes are small (as they often are), the spending variance is primarily a matter of the efficient use of overhead in production, which is controllable by production supervisors. Accordingly, responsibility for the variable overhead spending variance is generally assigned to production departments.

The $520 unfavourable spending variance simply reveals that, in the aggregate, Peterson Company spent more on variable overhead than expected. Even if the variance was insignificant, it reveals nothing about how well costs of individual variable overhead items were controlled. Control of variable overhead requires line-by-line analysis for each individual item. Exhibit 9-4 presents a performance report that supplies the line-by-line information essential for proper control of variable overhead. Assuming that Peterson investigates any item that deviates more than 10 percent from budget, the cost of electricity and water would be investigated. The investigation reveals that the utility companies increased the rates for electricity and water. The increase is expected to be permanent. In this case, the cause of the unfavourable variances is beyond the control of the company. The correct response is to revise the budget formula to reflect the increased cost of electricity and water.

Interpreting the Variable Overhead Efficiency Variance The variable overhead efficiency variance is directly related to the direct labour efficiency or usage variance. If variable overhead is truly driven by direct labour hours, then like the direct labour usage variance, the variable overhead efficiency variance is caused by efficient or

Exhibit 9-4

Variable Overhead Spending Variance by Item

Peterson Company
Performance Report
For the Month Ended May 31, 2013

	Cost Formula[a]	Actual Costs	Budget[b]	Spending Variance
Natural gas	$ 7.60	$ 9,640	$ 9,880	$240 F
Electricity	4.00	5,850	5,200	650 U
Water	0.40	630	520	110 U
Total	$12.00	$16,120	$15,600	$520 U

[a] Per direct labour hour.
[b] The budget allowance is computed using the cost formula and 1,300 actual direct labour hours.

inefficient use of direct labour. If more (or fewer) direct labour hours are used than the standard calls for, then the total variable overhead cost will increase (or decrease). The validity of the measure depends on the validity of the relationship between variable overhead costs and direct labour hours. In other words, do variable overhead costs *really* change in proportion to changes in direct labour hours? If so, responsibility for the variable overhead efficiency variance should be assigned to the individual who has responsibility for the use of direct labour: the production manager.

The reasons for the unfavourable variable overhead efficiency variance are generally the same as those offered for the unfavourable labour usage variance. For example, some of the variance can be explained by the fact that overtime hours were used during the first week to make up for a bad batch of yogurt. The remaining deficiency was caused by the use of new employees who took longer to carry out tasks because of their lack of experience.

More information concerning the effect of direct labour usage on variable overhead is available in a line-by-line analysis of individual variable overhead items. This can be accomplished by comparing the budget allowance for the actual hours used with the budget allowance for the standard hours allowed for each item. A performance report that makes this comparison for all variable overhead costs is shown in Exhibit 9-5. From Exhibit 9-5, we can see that the cost of natural gas is affected most by inefficient use of direct labour. For example, inexperienced labourers may heat the mix of gelatin and milk longer than is really needed, thus using more gas.

The column labelled *Budget for Standard Hours* gives the amount that should have been spent on variable overhead for the actual output. The total of all items in this column is the applied variable overhead, the amount assigned to production in a standard costing system. Note that in a standard costing system, variable overhead is applied using the hours allowed for the actual output (*SH*), while in normal costing, variable overhead is applied using actual hours. Although not shown in Exhibit 9-5, the difference between actual costs and this column is the total variable overhead variance (underapplied by $1,720). Thus, the underapplied variable overhead variance is the sum of the spending and efficiency variances.

Four-Variance Analysis: The Two Fixed Overhead Variances

The total fixed overhead variance is the difference between the actual fixed overhead and the applied fixed overhead. To help managers understand why fixed overhead may differ from applied fixed overhead, the total variance can be broken down into two variances: the fixed overhead spending variance and the fixed overhead volume variance.

Exhibit 9-5

Variable Overhead Spending and Efficiency Variances by Item

Peterson Company
Performance Report
For the Month Ended May 31, 2013

	Cost Formula[a]	Actual Costs	Budget[b]	Spending Variance	Budget for Standard Hours[c]	Efficiency Variance
Natural gas	$ 7.60	$ 9,640	$ 9,880	$240 F	$ 9,120	$ 760 U
Electricity	4.00	5,850	5,200	650 U	4,800	400 U
Water	0.40	630	520	110 U	480	40 U
Total	$12.00	$16,120	$15,600	$520 U	$14,400	$1,200 U

[a] Per direct labour hour.
[b] The budget allowance is computed using the cost formula and 1,300 actual direct labour hours.
[c] Standard hours for actual production equal 1,200 (0.01 hours × 120,000 litres).

Calculating the Fixed Overhead Spending Variance and Fixed Overhead Volume Variance

The **fixed overhead spending variance** is defined as the difference between the actual fixed overhead and the budgeted fixed overhead. If less is spent on fixed overhead items than was budgeted, the spending variance is favourable, and vice versa. The formula for computing the fixed overhead variance follows (*AFOH* = Actual fixed overhead and *BFOH* = Budgeted fixed overhead):

$$\text{Fixed overhead spending variance} = AFOH - BFOH$$

Any difference between actual fixed overhead and budgeted fixed overhead must be due to a change in the amount of fixed overhead—some item has increased or decreased vis-à-vis what was expected. This difference is called a spending variance.

The **fixed overhead volume variance** is the difference between budgeted fixed overhead and applied fixed overhead.

$$\text{Fixed overhead volume variance} = \text{Budgeted fixed overhead} - \text{Applied fixed overhead}$$

Keep in mind that the budgeted fixed overhead was determined in advance of the year, and that the fixed overhead rate, used to apply fixed overhead to production, was calculated then as well. Thus, the fixed overhead rate is the rate that it would take to apply fixed overhead to production *assuming that the actual production equals the budgeted production*. For example, if 2,000 units are budgeted, each unit taking three direct labour hours, then 6,000 direct labour hours are budgeted. If the budgeted fixed overhead is $24,000, then the fixed overhead rate would be $4. If 2,000 units are actually produced, then $24,000 will be applied to production ($4 × 2,000 units × 3 direct labour hours). There is no volume variance. Suppose instead that 2,100 units are actually produced. Then $25,200 ($4 × 2,100 units × 3 direct labour hours) is applied, an amount that is $1,200 higher than the budgeted fixed overhead. This difference is solely due to the increased production. We refer to this variance as "favourable" and a variance in which the actual production is less than budgeted as "unfavourable." As a rule, if actual production is less than budgeted production, the volume variance will be unfavourable; if actual production is more than budgeted production, the volume variance will be favourable.

Cornerstone 9-8 shows the how and why of calculating the fixed overhead spending and volume variances.

Interpreting the Fixed Overhead Variances

As was the case with the variable overhead variances, managers can gain useful information from the fixed overhead variances. However, due to the fixed nature of the costs involved, managers find that it is useful to spend time looking at fixed overhead on an item-by-item basis.

Interpreting the Fixed Overhead Spending Variance

Fixed overhead is made up of a number of individual items such as salaries, depreciation, taxes, and insurance. Many fixed overhead items—long-run investments, for instance—are not subject to change in the short run; consequently, fixed overhead costs are often beyond the immediate control of management. Since many fixed overhead costs are affected primarily by long-run decisions, not by changes in production levels, the budget variance is usually small. For example, depreciation, salaries, taxes, and insurance costs are not likely to be much different than planned.

Because fixed overhead is made up of many individual items, a line-by-line comparison of budgeted costs with actual costs provides more information concerning the causes of the spending variance. Exhibit 9-6 provides such a report. The report reveals that the fixed overhead spending variance is essentially in line with expectations. The fixed overhead spending variances, both on a line-item basis and in the aggregate, are relatively small (all less than 10 percent of the budgeted costs).

The HOW and WHY of Computing the Fixed Overhead Spending Variance and the Fixed Overhead Volume Variance

CORNERSTONE 9-8

Information:

Peterson Company provided the following information for the month of May:

Budgeted/planned items for May:		
Budgeted fixed overhead	$40,000	
Expected production in litres of frozen yogurt	100,000	
Expected activity in direct labour hours (0.01 × 100,000)	1,000	direct labour hours
Standard fixed overhead rate ($40,000/1,000)	$40	per direct labour hour
Actual results for May:		
Actual production of yogurt in litres	120,000	litres
Actual fixed overhead cost	$40,500	
Standard hours allowed for actual production (0.01 × 120,000)	1,200	direct labour hours

Why:

The total fixed overhead variance is broken into the fixed overhead spending and volume variances. The spending variance shows the difference between the actual fixed overhead and the budgeted fixed overhead. The volume variance shows the impact of a difference between actual units produced and the budgeted units. These variances indicate where managers could begin to investigate overhead variances.

Required:

1. Calculate the fixed overhead spending variance using the formula approach.
2. Calculate the fixed overhead volume variance using the formula approach.
3. Calculate the fixed overhead spending variance and fixed overhead volume variance using the three-pronged graphical approach.
4. ***What if*** only 95,000 litres of frozen yogurt had actually been produced in May? What impact would that have had on the fixed overhead spending variance? On the fixed overhead volume variance?

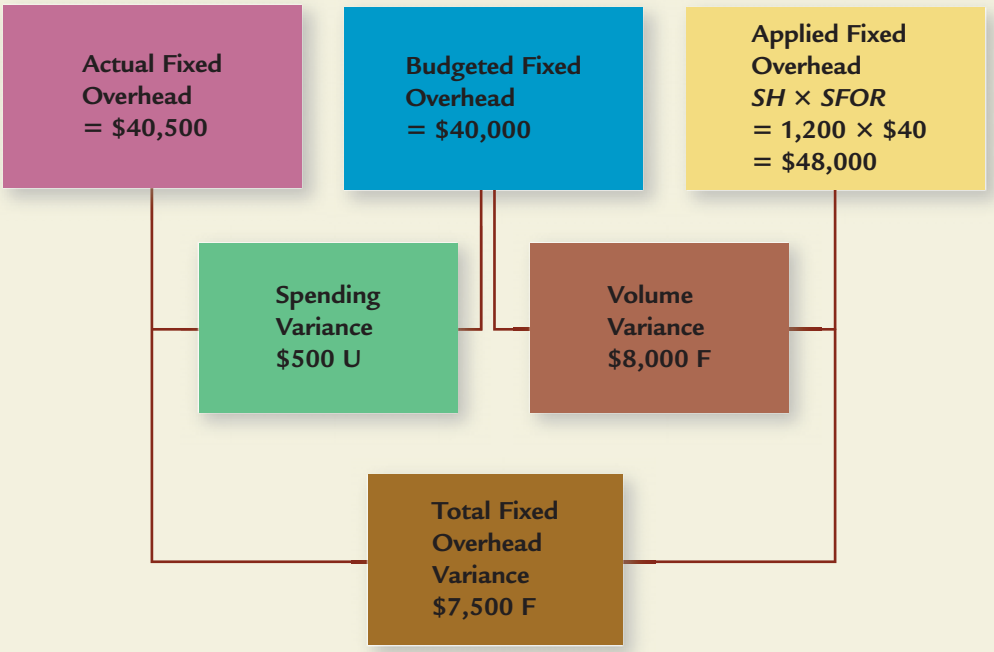
Solution:

1. Fixed overhead spending variance = Actual fixed overhead − Budgeted fixed overhead
   = $40,500 − $40,000
   = $500 U

2. Fixed overhead volume variance = Budgeted fixed overhead − Applied fixed overhead
   = Budgeted fixed overhead − (Fixed overhead rate × *SH*)
   = $40,000 − ($40 × 1,200) = $8,000 F

CORNERSTONE 9-8 *(continued)*

3.



4. If 95,000 litres had been produced in May, there would have been no impact on the fixed overhead spending variance (assuming that actual fixed overhead stayed the same). However, there would have been an unfavourable volume variance. That volume variance would have been $2,000 U [$40,000 – ($40 × 950)].

Exhibit 9-6

Fixed Overhead Spending Variance by Item

Peterson Company Performance Report For the Month Ended May 31, 2013			
	Actual Costs	**Budgeted Cost**	**Spending Variance**
Depreciation	$10,000	$10,000	$ 0
Salaries	26,300	25,800	500 U
Taxes	2,200	1,200	1,000 U
Insurance	2,000	3,000	1,000 F
Total	$40,500	$40,000	$ 500 U

Interpreting the Fixed Overhead Volume Variance The volume variance occurs because the actual output differs from the budgeted output or volume. At the beginning of the month, if management had expected 120,000 litres with 1,200 standard hours, the volume variance would not have existed. In this view, the volume variance is seen as prediction error—a measure of the inability of management to select the correct volume over which to spread fixed overhead.

If, however, the budgeted volume represented the amount that management believed *could* be produced and sold, the volume variance conveys more significant information. If the actual volume is more than the budgeted volume, the volume variance signals that a gain has occurred (relative to expectations). That gain is not equivalent, however, to the dollar value of the volume variance. The gain is equal to the increase in contribution margin on the extra units produced and sold. However, the volume variance is positively correlated with the gain. Suppose that the contribution margin per standard direct labour hour is $100. By producing 120,000 litres of frozen yogurt instead of 100,000 litres, the company gained sales of 20,000 litres. This is equivalent to 200 hours (0.01 × 20,000). At $100 per hour, the gain is $20,000 ($100 × 200). The favourable volume variance of $4,000 signals this gain but understates it. In this sense, the volume variance is a measure of this year's *planned* utilization of capacity.

On the other hand, if *practical capacity* is used as the budgeted volume, then the volume variance is a direct measure of capacity utilization. Practical capacity measures the most that can be produced under efficient operating conditions (and, thus, represents the productive capacity the firm has acquired). The difference between available hours of production and actual hours is a measure of underutilization, and when multiplied by the standard fixed overhead rate, the volume variance becomes a measure of the cost of underutilization of capacity. This is similar in concept to the activity capacity utilization measure described in Chapter 2. The principal difference is that the fixed overhead rate used to measure the cost of unused capacity contains more than the cost of acquiring the productive capacity. Fixed overhead is made up of many costs incurred for reasons other than obtaining productive capacity (e.g., the salaries of the plant supervisor, janitors, and industrial engineers).

Assuming that volume variance measures capacity utilization implies that the general responsibility for this variance should be assigned to the production department. At times, however, investigation into the reasons for a significant volume variance may reveal the cause to be factors beyond the control of production. Then, specific responsibility may be assigned elsewhere. For example, if purchasing acquires direct materials of lower quality than usual, significant rework time may result, causing lower production and an unfavourable volume variance. In this case, responsibility for the variance rests with purchasing, not production.

Accounting for Overhead Variances

Overhead is applied to production by debiting Work in Process and crediting variable and fixed overhead control accounts. The amount assigned is simply the respective overhead rates multiplied by the standard hours allowed for actual production. The actual overhead is accumulated on the debit side of the overhead control accounts. Periodically (e.g., monthly), overhead variance reports are prepared. At the end of the year, the applied variable and fixed overhead costs and the actual fixed overhead costs are closed out and the variances isolated. The overhead variances are then disposed of by closing them to Cost of Goods Sold if they are not material or by prorating them among Work in Process, Finished Goods, and Cost of Goods Sold if they are material. We will use the May transactions for Peterson Company to illustrate the process that would occur at the end of the year. Essentially, we are assuming that the May transactions reflect an entire year for illustrative purposes.

To recognize the incurrence of actual overhead, the following entry is needed:

Variable Overhead Control	16,120	
Fixed Overhead Control	40,500	
Various Accounts		56,620

To assign overhead to production, we have the following entry:

Work in Process	62,400	
Variable Overhead Control		14,400
Fixed Overhead Control		48,000

To recognize the variances, the following entry is needed:

Fixed Overhead Control	7,500	
Variable Overhead Spending Variance	520	
Variable Overhead Efficiency Variance	1,200	
Fixed Overhead Spending Variance	500	
Variable Overhead Control		1,720
Fixed Overhead Volume Variance		8,000

Finally, to close out the variances to Cost of Goods Sold, we would have the following entries. (Entries assume that variances are immaterial.)

Fixed Overhead Volume Variance	8,000	
Cost of Goods Sold		8,000
Cost of Goods Sold	2,220	
Variable Overhead Spending Variance		520
Variable Overhead Efficiency Variance		1,200
Fixed Overhead Spending Variance		500

Some students may find it easier to follow the flow of these transactions through the accounts by using T-accounts. In the end, all overhead and overhead variance accounts carry a zero balance.

Two- and Three-Variance Analysis Methods

One drawback of the four-variance method is that it requires a company to identify the actual variable and fixed costs as well as budgeted rates and costs. For companies that wish to avoid the need to track actual variable and fixed costs, the two- and three-variance methods can be used.

The two- and three-variance analyses do not require knowledge of actual variable and actual fixed overhead. These methods provide less detail and, thus, less information. We will simply present the method of computation for the two forms of analysis. The four-variance method is recommended over these two approaches. The May data for Peterson Company will be used to illustrate the two methods with the assumption that only the total actual overhead is known: $56,620.

Two-Variance Analysis The two-variance analysis is shown in Exhibit 9-7. (*SVOR* designates the standard variable overhead rate.) Several points should be made relative to the four-variance analysis shown in Cornerstones 9-7 and 9-8. First, the total variance is the sum of the total fixed and variable overhead variances. Second, the volume variance is the same as that of the four-variance method. Notice that in the computation of the volume variance, the applied variable overhead term, $SVOR \times SH$, is common to the middle and right prongs of the diagram. Thus, when the right number is subtracted from the left number, we are left with budgeted fixed overhead minus applied fixed overhead, which is the fixed overhead volume variance. Third, the budget variance is the sum of the spending and efficiency variances of the four-variance method ($520 U + $500 U + $1,200 U = $2,220 U). As indicated, the two-variance method sacrifices a lot of information.

Three-Variance Analysis The three-variance analysis is shown in Exhibit 9-8. Again, some observations can be made about this method relative to the four-variance method. First, the total variance is again the sum of the total variable and fixed overhead variances. Second, the spending variance is the sum of the variable and fixed overhead spending variances. The variable overhead efficiency and the fixed overhead volume variances are the same. The three-variance method also illustrates that the budget variance of the two-variance method breaks down into spending and efficiency variances.

Exhibit 9-7

Two-Variance Analysis: Peterson Company

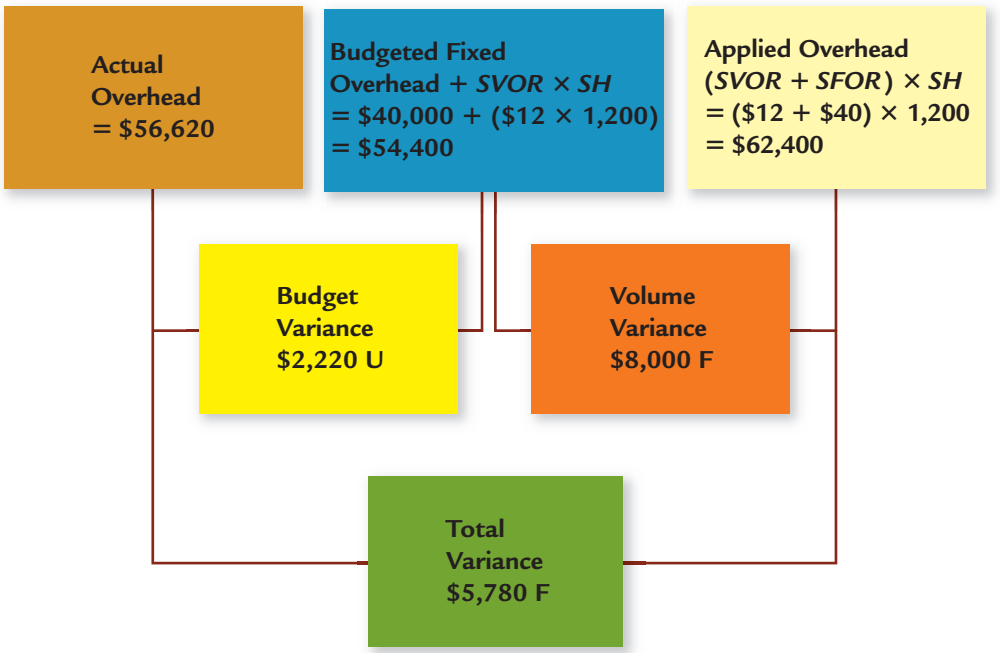
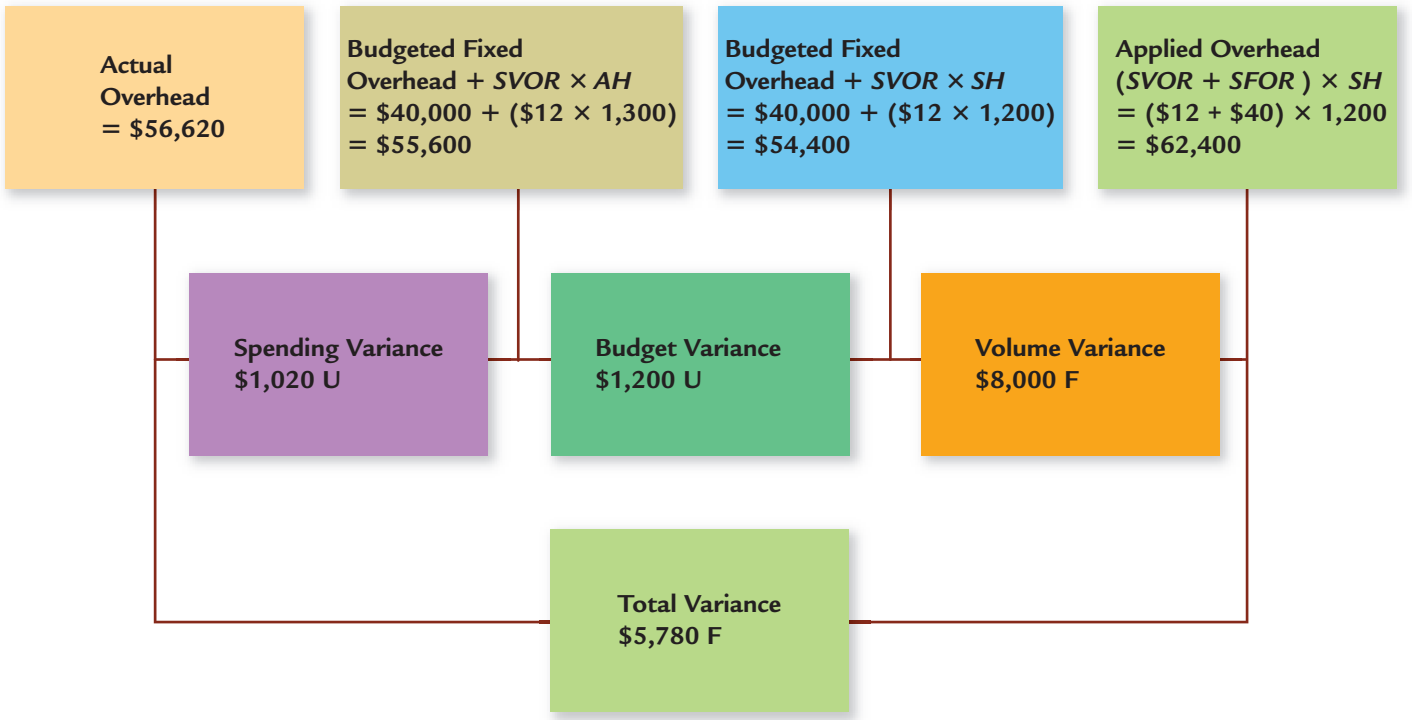


Exhibit 9-8

Three-Variance Analysis: Peterson Company



OBJECTIVE 5
Calculate mix and yield variances for direct materials and direct labour.

Mix and Yield Variances: Materials and Labour

For some production processes, it may be possible to substitute one direct material input for another or one type of direct labour for another. Usually, a standard mix specification identifies the proportion of each direct material and the proportion of each type of direct labour that should be used for producing the product. For example, in producing an orange-pineapple fruit drink, the standard direct materials mix may call for 30 percent pineapple and 70 percent orange, and the standard direct labour mix may call for 33 percent of fruit preparation labour and 67 percent of fruit processing labour. Clearly, within reason, it is possible to make input substitutions. Substituting direct materials or direct labour, however, may produce *mix* and *yield* variances. A **mix variance** is created whenever the actual mix of inputs differs from the standard mix. A **yield variance** occurs whenever the actual yield (output) differs from the standard yield. For example, a basic recipe for chocolate chip cookies says it will make three dozen two-inch cookies. But many of us who have baked these cookies know that you never get three dozen two-inch cookies because some of the cookie dough "disappears" before it ever gets to the baking sheet. This difference between the number of cookies you should get and the number you actually do get is the yield variance. For direct materials, the sum of the mix and yield variances equals the direct materials usage variance; for direct labour, the sum is the direct labour efficiency variance.

Direct Materials Mix Variance

The mix variance is the difference in the standard cost of the actual mix of inputs used and the standard cost of the mix of inputs that should have been used. Let *SM* be the quantity of each input that should have been used given the total actual input quantity. This quantity is computed as follows for each direct material input:

$$SM = \text{Standard mix proportion} \times \text{Total actual input quantity}$$

The standard mix quantity is computed for each input.[6] The total actual input quantity is the sum of the quantities of all inputs put into production.

Given *SM*, the mix variance is computed as follows:

$$\text{Mix variance} = \Sigma(AQi - SMi)SPi \qquad (9.1)$$

Basically, the mix variance is the sum of the differences between the actual amount of each input and its standard mix amount, multiplied by the standard price. If relatively more of a more expensive input is used, the mix variance will be unfavourable. If relatively more of a less expensive input is used, the mix variance will be favourable. Cornerstone 9-9 shows the how and why of calculating the mix variance.

Notice in Cornerstone 9-9 that the mix variance is unfavourable. This occurs because more almonds are used than are called for in the standard mix, and almonds are a more expensive input. If the mix variance is material, then an investigation should be undertaken to determine the cause of the variance so that corrective action can be taken.

Notice that Cornerstone 9-9 can also be used to calculate the mix variance for inputs other than direct materials. For example, there may be different types of direct labour needed to make a product. It is possible to substitute relatively more of a more or less expensive type of direct labour and obtain a direct labour mix variance.

Direct Materials Yield Variance

The direct materials yield variance is designed to show the extent to which the amount of input resulted in the expected amount of output. Using the standard mix

[6] The standard mix amounts are not the standard quantities allowed for actual output. The total standard quantity allowed is computed by dividing the actual yield by the standard yield ratio. The total standard input allowed is then multiplied by the standard mix ratios to compute the quantity of each direct material input that should have been used of the actual output. Alternatively, the unit direct material standards can be developed by dividing the standard input mix quantity by the standard yield. Multiplying the unit standards by the actual yield will also produce *SQ* for each input.

The HOW and WHY of Computing the Mix Variance

CORNERSTONE 9-9

Information:

Malcom Nut Company produces mixed nuts using peanuts and almonds. Malcom developed the following standard mix for producing 120 kilograms of mixed nuts. (Almonds and peanuts are purchased in the shell and processed.)

Direct Material	Mix	Mix Proportion	*SP*	Standard Cost
Peanuts	128 kg	0.80	$0.50	$64
Almonds	32	0.20	1.00	32
Total	160 kg			$96

Malcom put a batch of 1,600 kilograms of nuts into process. Of the total, 1,120 kilograms were peanuts, and the remaining 480 kilograms were almonds. The actual yield was 1,300 kilograms.

Why:

The materials usage variance tells managers whether total materials are in accordance with standards. The mix variance gives further information about materials usage since different materials have different standard prices.

Required:

1. Calculate the standard mix (*SM*) in kilograms for peanuts and for almonds.
2. Calculate the mix variance.
3. Calculate the actual proportion used of peanuts and almonds. Use these results to explain why the mix variance is unfavourable.
4. ***What if*** of the total 1,600 kilograms of nuts put into process, 1,360 kilograms were peanuts and 240 kilograms were almonds? How would that affect the mix variance?

Solution:

1. *SM* = Standard mix proportion × Total actual input quantity

   SM peanuts = 0.80 × 1,600 = 1,280 kilograms

   SM almonds = 0.20 × 1,600 = 320 kilograms

2. The formula can be applied most easily using the following approach:

Direct Material	*AQ*	*SM*	*AQ* − *SM*	*SP*	*(AQ* − *SM)SP*
Peanuts	1,120	1,280	(160)	$0.50	$ (80)
Almonds	480	320	160	1.00	160
Mix variance					$ 80 U

3. Actual mix proportion peanuts = 1,120/1,600 = 0.70, or 70%

   Actual mix proportion almonds = 480/1,600 = 0.30, or 30%

   The mix variance is unfavourable because a larger percentage of the relatively more expensive input, almonds, was used.

4. Since peanuts now account for 85 percent (1,360/1,600) of the total, almonds account for only 15 percent. The mix variance will be favourable since relatively more peanuts, the cheaper input, are used.

CORNERSTONE 9-10

The HOW and WHY of Computing the Yield Variance

Information:

Malcom Nut Company produces mixed nuts using peanuts and almonds. Malcom developed the following standard mix for producing 120 kilograms of mixed nuts. (Almonds and peanuts are purchased in the shell and processed.)

Direct Material	Mix	Mix Proportion	*SP*	Standard Cost
Peanuts	128 kg	0.80	$0.50	$64
Almonds	32	0.20	1.00	32
Total	160 kg			$96

Malcom put a batch of 1,600 kilograms of nuts into process. Of the total, 1,120 kilograms were peanuts, and the remaining 480 kilograms were almonds. The actual yield was 1,300 kilograms.

Why:

The yield variance tells managers whether total inputs resulted in the amount of output expected.

Required:

1. Calculate the yield ratio based on the standard amounts given.
2. Calculate the standard cost per kilogram of the yield.
3. Calculate the standard yield for actual input of 1,600 kilograms of nuts.
4. Calculate the yield variance.
5. ***What if*** the total 1,600 kilograms of nuts put into process resulted in a yield of 1,190? How would that affect the yield variance?

Solution:

1. Using the standard mix for 120 kilograms of mixed nuts:
   Yield ratio = 120 kilograms of output/160 kilograms of input = 0.75
2. Standard cost of the yield (*SPy*) = $96/120 kilograms of yield
   = $0.80 per kilogram
3. Standard yield = Yield ratio × Actual amount of inputs
   = 0.75 × 1,600 kilograms = 1,200 kilograms
4. Yield variance = (Standard yield − Actual yield)*SPy*
   = (1,200 − 1,300)$0.80 = $80 F
5. If the 1,600 kilograms of nuts put into process resulted in only 1,190 kilograms of mixed nuts, then the yield variance would be unfavourable. That is, the actual yield of 1,190 is less than the standard yield of 1,200.

information and the actual results, the yield variance is computed by the following formula:

$$\text{Yield variance} = (\text{Standard yield} - \text{Actual yield})SPy \quad (9.2)$$

where

Standard yield = Yield ratio × Total actual inputs
Yield ratio = Total output/Total input
SPy = Standard cost of the yield (equal to total cost of a standard batch divided by the amount of the yield)

Cornerstone 9-10 shows the how and why of calculating the yield variance.

The yield variance in Cornerstone 9-10 is favourable because the actual yield is greater than the standard yield. Direct material yield variance should be investigated

to find the root causes. Corrective action to restore the process to the standards may be required or it may lead to a change in standards if the joint effect of the mix and yield variances is favourable.

Direct Labour Mix and Yield Variances

The direct labour mix and yield variances are computed in the same way as the direct materials mix and yield variances. Specifically, Equations 9.1 and 9.2 apply to direct labour in the same way with the notation defined appropriately for direct labour. For example, *AQ*, in Equation 9.1, is interpreted as *AH*, the actual hours used, and *SP* as the standard price of labour. With this understanding, the computation of mix and yield variances will be illustrated using the Malcom Nut Company example. Suppose that Malcom has two types of direct labour, shelling labour and mixing labour. Malcom has developed the following standard mix for direct labour. (Yield, of course, is measured in kilograms of output and corresponds to the same batch size used for the direct materials standards.)

Standard Mix Information: Direct Labour

Direct Labour Type	Mix	Mix Proportion	*SP*	Standard Cost
Shelling	3 hrs	0.60	$ 8.00	$24
Mixing	2	0.40	15.00	30
Total	5 hrs			$54
Yield	120 kg			

Yield ratio: 24 = (120/5), or 2,400%

Standard cost of the yield (*SPy*) : $0.45 per kilogram (54/120 kilograms of yield)

Suppose that Malcom processes 1,600 kilograms of nuts and produces the following actual results:

Direct Labour Type	Actual	Mix Percentages*
Shelling	20 hrs	40.0%
Mixing	30	60.0
Total	50 hrs	100.0%
Yield	1,300 kg	2,600.0%

*Uses 50 hours as the base.

Direct Labour Mix Variance The standard mix proportion for shelling labour is 0.60. Thus, if 50 hours of actual input is used, then the mix standard calls for the following amount of shelling labour:

$$SM(\text{shelling}) = 0.60 \times 50$$
$$= 30 \text{ hours}$$

A similar computation produces $SM = 20$ hours for mixing labour (0.40×50).

Given *SM*, the direct labour mix variance is computed as follows (using Equation 9.1):

Direct Labour Type	*AH*	*SM*	*AH* − *SM*	*SP*	(*AH* − *SM*)*SP*
Shelling	20	30	(10)	$ 8.00	$ (80)
Mixing	30	20	10	15.00	150
Direct labour mix variance					$ 70 U

Notice that the direct labour mix variance is unfavourable. This occurs because more mixing labour was used than was called for in the standard mix, and mixing labour is more expensive than shelling labour.

Direct Labour Yield Variance Using the standard mix information and the actual results, the direct labour yield variance is computed as follows:

$$\begin{aligned}\text{Direct labour yield variance} &= (\text{Standard yield} - \text{Actual yield})SPy \\ &= [(24 \times 50) - 1{,}300]\$0.45 \\ &= (1{,}200 - 1{,}300)\$0.45 \\ &= \$45\ \text{F}\end{aligned}$$

The direct labour yield variance is favourable because the actual yield is greater than the standard yield.

Summary of Learning Objectives

1. Describe how unit input standards are developed, and explain why standard costing systems are adopted.

- A standard costing system budgets quantities and costs on a unit basis for direct labour, direct materials, and overhead.
- Standard costs are the amount that should be expended to produce a product or service. They are set using:
  - Historical experience,
  - Engineering studies, and
  - Input from operating personnel, marketing, and accounting.
- Currently attainable standards are those that can be achieved under efficient operating conditions.
- Ideal standards are those achievable under maximum efficiency or ideal operating conditions.
- Standard costing systems are used for:
  - Planning
  - Operating
  - Control
  - Decision making

2. Explain the purpose of a standard cost sheet.

- The standard cost sheet shows the amount and cost of direct materials, direct labour, and overhead needed to make one unit of output.
- Using these unit quantity standards, the standard quantity of direct materials allowed and the standard hours allowed can be computed for the actual output.
- These computations play an important role in variance analysis.

3. Compute and journalize the direct materials and direct labour variances, and explain how they are used for control.

- The direct materials price variance compares the actual price of materials with the standard price. This difference is multiplied by the actual amount purchased.
- The direct materials usage variance compares the actual amount of materials used with the standard amount of materials for actual production. This difference is multiplied by the standard price.
- The direct labour rate variance is the difference between actual wage and standard wage multiplied by the actual number of direct labour hours.
- The direct labour efficiency variance is the difference between the actual hours worked and the standard hours for actual production multiplied by the standard wage.
- All variances are closed out at the end of the year.
  - Immaterial variances are closed to Cost of Goods Sold.
  - Material variances are prorated among Work in Process, Finished Goods, and Cost of Goods Sold.

4. Compute overhead variances three different ways, and explain overhead accounting.

- The four-variance method is the most detailed. It includes the following variances:
  - Variable overhead spending variance
  - Variable overhead efficiency variance
  - Fixed overhead spending variance
  - Fixed overhead volume variance
- The three-variance method does not require dividing costs into fixed and variable amounts. It includes the following variances:
  - Spending variance
  - Efficiency variance
  - Volume variance
- The two-variance method does not require dividing costs into fixed and variable amounts. It includes the following variances:
  - Budget variance
  - Volume variance

5. Calculate mix and yield variances for direct materials and direct labour.

- The mix variance shows the impact of different input proportions on the cost of the output.
- The yield variance shows the difference between the amount of output that was produced versus the expected output for a given amount of input.

CORNERSTONES FOR CHAPTER 9

Review Problem

Materials, Labour, and Overhead Variances

Aylmer Manufacturing has the following standard cost sheet for one of its products:

Direct materials (2 metres @ $15)	$30
Direct labour (1.5 hours @ $10)	15
Fixed overhead (1.5 hours @ $2*)	3
Variable overhead (1.5 hours @ $4)	6
Standard unit cost	$54

*Rate based on expected activity of 17,000 hours.

During the most recent year, the following actual results were recorded:

Production	12,000 units
Fixed overhead	$33,000
Variable overhead	$69,000
Direct materials (23,920 m purchased)	$361,192
Direct labour (17,900 hours)	$182,580

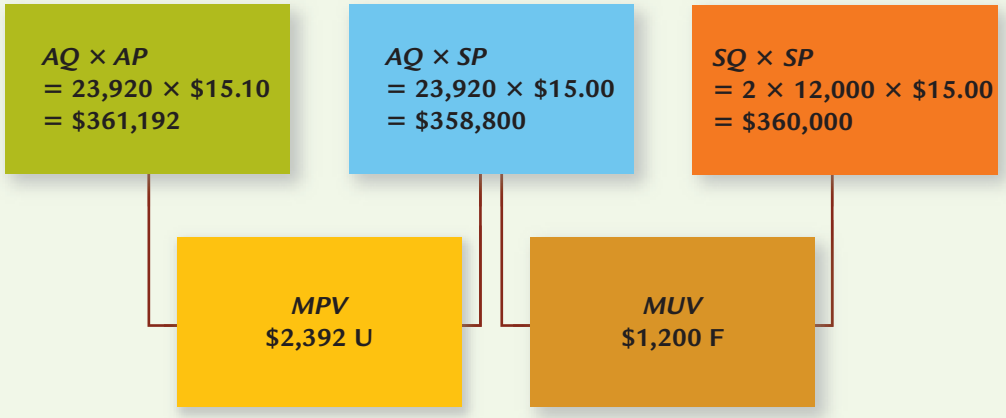
Required:

Compute the following variances:

1. Direct materials price and usage variances.
2. Direct labour rate and efficiency variances.
3. Variable overhead spending and efficiency variances.
4. Fixed overhead spending and volume variances.

Solution:

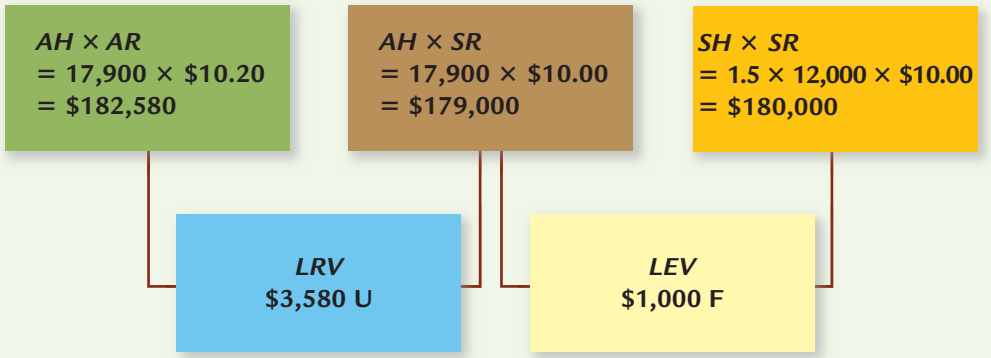
1. Direct materials variances:



Or, using formulas:

$$\begin{aligned} MPV &= (AP - SP)AQ \\ &= (\$15.10 - \$15.00)23{,}920 \\ &= \$2{,}392 \text{ U} \\ MUV &= (AQ - SQ)SP \\ &= (23{,}920 - 24{,}000)\$15.00 \\ &= \$1{,}200 \text{ F} \end{aligned}$$

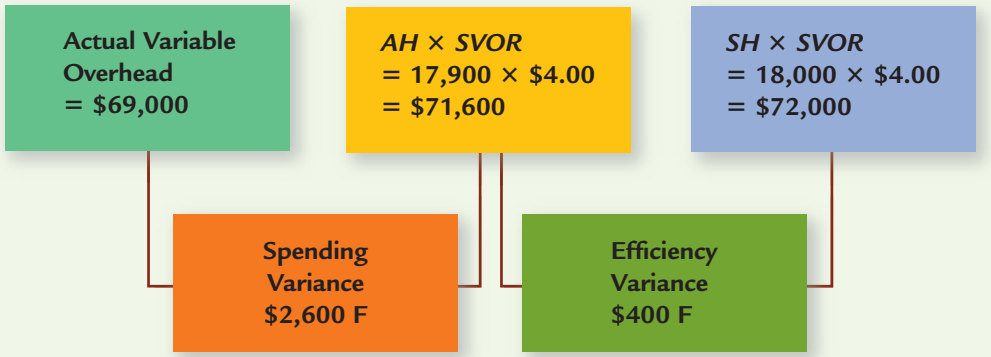
2. Direct labour variances:



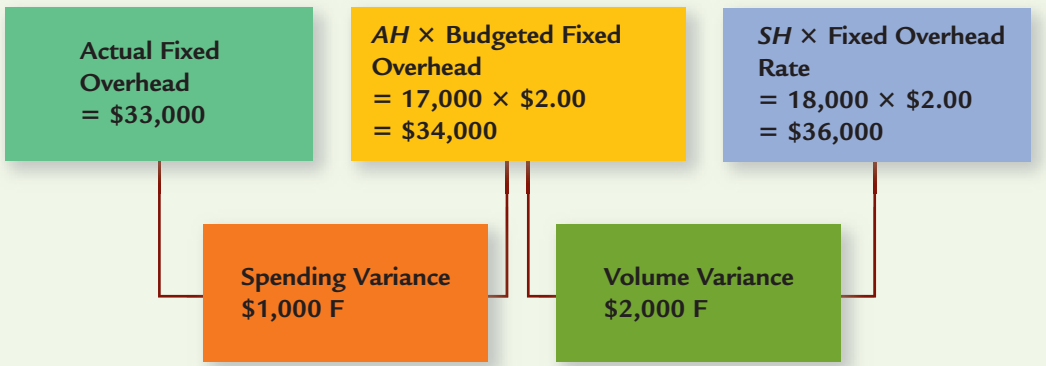
Or, using formulas:

$$
\begin{aligned}
LRV &= (AR - SR)AH \\
&= (\$10.20 - \$10.00)17{,}900 \\
&= \$3{,}580 \text{ U} \\
LEV &= (AH - SH)SR \\
&= (17{,}900 - 18{,}000)\$10.00 \\
&= \$1{,}000 \text{ F}
\end{aligned}
$$

3. Variable overhead variances:



4. Fixed overhead variances:



Key Terms

Control limits, 448
Currently attainable standards, 436
Direct labour efficiency variance (*LEV*), 447
Direct labour rate variance (*LRV*), 447
Direct materials price variance (*MPV*), 441
Direct materials usage variance (*MUV*), 441
Favourable (F) variance, 441
Fixed overhead spending variance, 458
Fixed overhead volume variance, 458
Ideal standards, 436
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Mix variance, 464
Price (rate) variance, 440
Price standards, 436
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Standard bill of materials, 444
Standard cost per unit, 438
Standard cost sheet, 438
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Total budget variance, 439
Unfavourable (U) variance, 441
Unit standard cost, 436
Usage (efficiency) variance, 440
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Variable overhead spending variance, 453
Yield variance, 464

Discussion Questions

1. Discuss the difference between budgets and standard costs.
2. What is the quantity decision? The pricing decision?
3. Why is historical experience often a poor basis for establishing standards?
4. What are ideal standards? Currently attainable standards? Of the two, which is usually adopted? Why?
5. How does standard costing improve the control function?
6. The budget variance for variable production costs is broken down into quantity and price variances. Explain why the quantity variance is more useful for control purposes than the price variance.
7. Explain why the direct materials price variance is often computed at the point of purchase rather than at the point of issuance.
8. The direct materials usage variance is always the responsibility of the production supervisor. Do you agree or disagree? Why?
9. The direct labour rate variance is never controllable. Do you agree or disagree? Why?
10. Suggest some possible causes of an unfavourable direct labour efficiency variance.
11. Explain why the variable overhead spending variance is not a pure price variance.
12. What is the cause of an unfavourable volume variance? Does the volume variance convey any meaningful information to managers?
13. What are control limits, and how are they set?
14. Explain how the two-, three-, and four-variance overhead analyses are related.
15. Explain what mix and yield variances are.

Cornerstone Exercises

OBJECTIVE 1
CORNERSTONE 9-1
SERVICE

Cornerstone Exercise 9-1 CALCULATING STANDARD QUANTITIES FOR ACTUAL PRODUCTION

Squadrone's Oil and Lube Company is a service company that offers oil changes and lubrication for automobiles and light trucks. On average, Squadrone has found that a typical oil change takes 30 minutes and 6 litres of oil are used. In June, Squadrone's Oil and Lube had 780 oil changes.

Required:

1. Calculate the number of litres of oil that should have been used (*SQ*) for 780 oil changes.
2. Calculate the hours of direct labour that should have been used (*SH*) for 780 oil changes.
3. ***What if*** there had been 740 oil changes in June? Would the standard quantities of oil (in litres) and of direct labour hours be higher or lower than the amounts calculated in Requirements 1 and 2? What would the new standard quantities be?

Cornerstone Exercise 9-2 CALCULATING THE DIRECT MATERIALS PRICE VARIANCE AND THE DIRECT MATERIALS USAGE VARIANCE

OBJECTIVE 3
CORNERSTONE 9-2
SERVICE

Refer to **Cornerstone Exercise 9-1**. Squadrone's Oil and Lube Company provided the following information for the production of oil changes during the month of June:

Actual number of oil changes performed: 780
Actual number of litres of oil used: 4,517 litres
Actual price paid per litre of oil: $6.40
Standard price per litre of oil: $6.20

Required:

1. Calculate the direct materials price variance (*MPV*) and the direct materials usage variance (*MUV*) for June using the formula approach.
2. Calculate the direct materials price variance (*MPV*) and the direct materials usage variance (*MUV*) for June using the graphical approach.
3. Calculate the total direct materials variance for oil for June.
4. ***What if*** the actual number of litres of oil purchased in June had been 4,530 litres, and the materials price variance was calculated at the time of purchase? What would be the materials price variance (*MPV*)? The materials usage variance (*MUV*)?

Cornerstone Exercise 9-3 CALCULATING THE DIRECT LABOUR RATE VARIANCE AND THE DIRECT LABOUR EFFICIENCY VARIANCE

OBJECTIVE 3
CORNERSTONE 9-3
SERVICE

Refer to **Cornerstone Exercise 9-1**. Squadrone's Oil and Lube Company provided the following information for the production of oil changes during the month of June:

Actual number of oil changes performed: 780
Actual number of direct labour hours worked: 410 hours
Actual rate paid per direct labour hour: $12.00
Standard rate per direct labour hour: $12.00

Required:

1. Calculate the direct labour rate variance (*LRV*) and the direct labour efficiency variance (*LEV*) for June using the formula approach.
2. Calculate the direct labour rate variance (*LRV*) and the direct labour efficiency variance (*LEV*) for June using the graphical approach.
3. Calculate the total direct labour variance for oil changes for June.
4. ***What if*** the actual wage rate paid in June was $12.40? What impact would that have had on the direct labour rate variance (*LRV*)? On the direct labour efficiency variance (*LEV*)?

Cornerstone Exercise 9-4 USING CONTROL LIMITS TO DETERMINE WHEN TO INVESTIGATE A VARIANCE

OBJECTIVE 3
CORNERSTONE 9-4

Laurier Company set a standard cost for one item at $230,000; allowable deviation is ±$8,000. Actual costs for the past six months are as follows:

June	$237,000	September	$221,500
July	238,900	October	225,500
August	245,000	November	230,150

Required:

1. Calculate the variance from standard for each month. Which months should be investigated?
2. ***What if*** the company uses a two-part rule for investigating variances? The allowable deviation is the lesser of 3 percent of the standard amount or $8,000. Now which months should be investigated?

OBJECTIVE 3
CORNERSTONE 9-5

Cornerstone Exercise 9-5 CLOSING THE BALANCES IN THE VARIANCE ACCOUNTS AT THE END OF THE YEAR

Baxter Company has the following balances in its direct materials and direct labour variance accounts at year-end:

	Debit	Credit
Direct Materials Price Variance		$17,800
Direct Materials Usage Variance		3,000
Direct Labour Rate Variance		500
Direct Labour Efficiency Variance	$21,000	

Unadjusted Cost of Goods Sold equals $560,000, unadjusted Work in Process equals $175,000, and unadjusted Finished Goods equals $80,000.

Required:

1. Assume that the ending balances in the variance accounts are immaterial and prepare the journal entries to close them to Cost of Goods Sold. What is the adjusted balance in Cost of Goods Sold after closing out the variances?
2. ***What if*** any ending balance in a variance account that exceeds $10,000 is considered material? Close the immaterial variance accounts to Cost of Goods Sold and prorate the material variances among Cost of Goods Sold, Work in Process, and Finished Goods. The prime cost in Cost of Goods Sold is $400,000, the prime cost in Work in Process is $125,000, and the prime cost in Finished Goods is $56,800. What are the adjusted balances in Work in Process, Finished Goods, and Cost of Goods Sold after closing out all variances?

OBJECTIVE 4
CORNERSTONE 9-6

Cornerstone Exercise 9-6 CALCULATING THE TOTAL OVERHEAD VARIANCE

Asher Company manufactures consumer products and provided the following information for the month of February:

Units produced	119,000
Standard direct labour hours per unit	0.25
Standard variable overhead rate (per direct labour hour)	$3.40
Actual variable overhead costs	$102,300
Actual hours worked	30,100

Required:

1. Calculate the total variable overhead variance.
2. ***What if*** actual production had been 120,600 units? How would that affect the total variable overhead variance?

OBJECTIVE 1
CORNERSTONE 9-7

Cornerstone Exercise 9-7 CALCULATING THE VARIABLE OVERHEAD SPENDING AND EFFICIENCY VARIANCES

Refer to **Cornerstone Exercise 9-6**.

Required:

1. Calculate the variable overhead spending variance using the formula approach. (If you compute the actual variable overhead rate, carry your computations out to five significant digits and round the variance to the nearest dollar.)
2. Calculate the variable overhead efficiency variance using the formula approach.

3. Calculate the variable overhead spending variance and variable overhead efficiency variance using the three-pronged graphical approach.
4. ***What if*** 30,200 direct labour hours were actually worked in February? What impact would that have had on the variable overhead spending variance? On the variable overhead efficiency variance?

Cornerstone Exercise 9-8 CALCULATING THE FIXED OVERHEAD SPENDING AND VOLUME VARIANCES

OBJECTIVE 4
CORNERSTONE 9-8

Asher Company manufactures consumer products and provided the following information for the month of February:

Units produced	119,000
Standard direct labour hours per unit	0.25
Standard fixed overhead rate (per direct labour hour)	$2.50
Budgeted fixed overhead	$75,000
Actual fixed overhead costs	$78,300
Actual hours worked	30,100

Required:

1. Calculate the fixed overhead spending variance using the formula approach.
2. Calculate the fixed overhead volume variance using the formula approach.
3. Calculate the fixed overhead spending variance and fixed overhead volume variance using the three-pronged graphical approach.
4. ***What if*** 120,700 units had actually been produced in February? What impact would that have had on the fixed overhead spending variance? On the fixed overhead volume variance?

Cornerstone Exercise 9-9 CALCULATING THE DIRECT MATERIALS MIX VARIANCE

OBJECTIVE 5
CORNERSTONE 9-9

Naples Pizza Company makes frozen pizzas that are sold through grocery stores. Naples developed the following standard mix for spreading on premade pizza shells to produce 16 giant-size sausage pizzas.

Direct Material	Mix	Mix Proportion	*SP*	Standard Cost
Tomato sauce	10 kg	0.25	$1.60	$16
Cheese	20	0.50	2.60	52
Sausage	10	0.25	2.00	20
Total	40 kg			$88

Naples put a batch of 2,000 kilograms of direct materials (enough for 800 frozen sausage pizzas) into process. Of the total, 460 kilograms were tomato sauce, 1,040 kilograms were cheese, and the remaining 500 kilograms were sausage. The actual yield was 780 pizzas.

Required:

1. Calculate the standard mix (*SM*) in kilograms for tomato sauce, for cheese, and for sausage.
2. Calculate the mix variance.
3. Calculate the actual proportion used of tomato sauce, cheese, and sausage. Use these results to explain the direction (favourable or unfavourable) of the mix variance.
4. ***What if*** of the total 2,000 kilograms of ingredients put into process, 600 kilograms were tomato sauce, 900 kilograms were cheese, and 500 kilograms were sausage? How would that affect the mix variance?

OBJECTIVE 5
CORNERSTONE 9-9

Cornerstone Exercise 9-10 CALCULATING THE DIRECT LABOUR MIX VARIANCE

Naples Pizza Company makes frozen pizzas that are sold through grocery stores. Naples uses two types of direct labour: machine operators and packers. Naples developed the following standard mix of direct labour to produce 16 giant-size sausage pizzas.

Direct Labour	Mix	Mix Proportion	*SP*	Standard Cost
Machine operators	0.5 hr	0.50	$16	$ 8
Packers	0.5	0.50	12	6
Total	1.0 hr			$14

Naples's recent batch (designed to produce 6,400 pizzas) used 400 direct labour hours. Of the total, 160 were for machine operators, and the remaining 240 hours were for packers. The actual yield was 6,240 pizzas.

Required:

1. Calculate the standard mix (*SM*) in hours for machine operators and for packers.
2. Calculate the mix variance.
3. Calculate the actual proportion of hours worked by machine operators and by packers. Use these results to explain the direction (favourable or unfavourable) of the mix variance.
4. ***What if*** of the total 400 direct labour hours worked, 200 were worked by each type of direct labour? How would that affect the mix variance?

OBJECTIVE 5
CORNERSTONE 9-10

Cornerstone Exercise 9-11 CALCULATING THE YIELD VARIANCE

Refer to **Cornerstone Exercise 9-9**.

Required:

1. Calculate the yield ratio based on the standard amounts given.
2. Calculate the standard cost per kilogram of the yield.
3. Calculate the standard yield for actual input of 2,000 kilograms of direct materials.
4. Calculate the yield variance.
5. ***What if*** the total 2,000 kilograms of direct materials put into process resulted in a yield of 825 pizzas? How would that affect the yield variance?

Exercises

OBJECTIVE 2

Exercise 9-12 COMPUTATION OF INPUTS ALLOWED, DIRECT MATERIALS AND DIRECT LABOUR

During the year, Atwood Company produced 280,000 lathe components for industrial metal working machinery. Atwood's direct materials and direct labour standards per unit are as follows:

Direct materials (5.20 kg @ $3.60)	$18.72
Direct labour (0.75 hr @ $15)	11.25

Required:

1. Compute the standard kilograms of direct materials allowed for the production of 280,000 units.
2. Compute the standard direct labour hours allowed for the production of 280,000 units.

OBJECTIVE 3

Exercise 9-13 DIRECT MATERIALS AND LABOUR VARIANCES

Timmons Company produces a dark chocolate candy bar. Recently, the company adopted the following standards for one 500-gram bar:

Direct materials (525 g @ $0.16 per 100 g)	$0.84
Direct labour (0.07 hr @ $18.00)	1.26
Standard prime cost	$2.10

During the first week of operation, the company experienced the following actual results:

a. Bars produced: 78,000.
b. Kilograms of direct materials purchased: 41,600 kilograms at $0.175 per 100 grams.
c. There are no beginning inventories of direct materials.
d. Direct labour: 5,510 hours at $18.00.

Required:

1. Compute price and usage variances for direct materials.
2. Compute the rate variance and the efficiency variance for direct labour.
3. Prepare the journal entries associated with direct materials and direct labour.

Exercise 9-14 OVERHEAD VARIANCES, FOUR-VARIANCE ANALYSIS

OBJECTIVE 4

Fellers Inc. uses a standard costing system and develops its overhead rates from the current annual budget. The budget is based on an expected annual output of 160,000 units requiring 640,000 direct labour hours. (Practical capacity is 700,000 hours.) Annual budgeted overhead costs total $723,200, of which $243,200 is fixed overhead. A total of 163,400 units using 655,000 direct labour hours were produced during the year. Actual variable overhead costs for the year were $496,750, and actual fixed overhead costs were $245,800.

Required:

1. Compute the fixed overhead spending and volume variances. How would you interpret the spending variance? Discuss the possible interpretations of the volume variance. Which is most appropriate for this example?
2. Compute the variable overhead spending and efficiency variances. How is the variable overhead spending variance like the price variances of direct labour and direct materials? How is it different? How is the variable overhead efficiency variance related to the direct labour efficiency variance?

Exercise 9-15 OVERHEAD VARIANCES, TWO- AND THREE-VARIANCE ANALYSES

OBJECTIVE 4

Refer to the data in **Exercise 9-14**.

Required:

1. Compute overhead variances using a two-variance analysis.
2. Compute overhead variances using a three-variance analysis.
3. Illustrate how the two- and three-variance analyses are related to the four-variance analysis.

Exercise 9-16 DIRECT MATERIALS MIX AND YIELD VARIANCES

OBJECTIVE 5

Chypre Inc. produces a cologne mist using a solvent mix (water and pure alcohol) and aromatic compounds (the scent base) which it sells to other companies for bottling and sale to consumers. Chypre developed the following standard cost sheet:

Direct Material	Mix	Mix Proportion	*SP*	Standard Cost
Solvent mix	760 litres	0.95	$ 5.27	$ 4,005.20
Aromatic compounds	40	0.05	8,000.00	320,000.00
Total	800 litres			$324,005.20
Yield	720 litres			

On May 2, Chypre produced a batch of 1,000 litres with the following actual results:

Direct Material	Actual Mix
Solvent mix	945 litres
Aromatic compounds	55
Total	1,000 litres
Yield	880 litres

Required:

1. Calculate the yield ratio.
2. Calculate the standard cost per unit of the yield. (Round to the nearest cent.)
3. Calculate the direct materials yield variance. (Round to the nearest cent.)
4. Calculate the direct materials mix variance. (Round to the nearest cent.)

OBJECTIVE 3 5

Exercise 9-17 DIRECT MATERIALS VARIANCES, JOURNAL ENTRIES

Refer to **Exercise 9-16**. Chypre Inc. purchased the amount used of each direct material input on May 2 for the following actual prices: solvent mix, $5.20 per litre and aromatic compound, $8,010 per litre.

Required:

1. Compute and journalize the direct materials price variances.
2. Compute and journalize the direct materials usage variances.
3. Offer some possible reasons for why the variances occurred.

OBJECTIVE 5

Exercise 9-18 DIRECT LABOUR MIX AND YIELD VARIANCES

Delano Company uses two types of direct labour for the manufacturing of its products: fabricating and assembly. Delano has developed the following standard mix for direct labour, where output is measured in number of circuit boards.

Direct Labour Type	Mix	*SP*	Standard Cost
Fabricating	2 hrs	$20	$40
Assembly	3	12	36
Total	5 hrs		$76
Yield	25 units		

During the second week in April, Delano produced the following results:

Direct Labour Type	Actual Mix
Fabricating	20,000 hrs
Assembly	45,000
Total	65,000 hrs
Yield	320,000 units

Required:

1. Calculate the yield ratio.
2. Calculate the standard cost per unit of the yield.
3. Calculate the direct labour yield variance.
4. Calculate the direct labour mix variance.

OBJECTIVE 3

Exercise 9-19 DIRECT LABOUR AND DIRECT MATERIALS VARIANCES, JOURNAL ENTRIES

Ivanov Company produces paper towels. The company has established the following direct materials and direct labour standards for one case of paper towels:

Paper pulp (3 kg @ $0.40)	$ 1.20
Labour (2 hrs @ $12)	24.00
Total prime cost	$25.20

During the first quarter of the year, Ivanov produced 45,000 cases of paper towels. The company purchased and used 135,700 kilograms of paper pulp at $0.38 per kilogram. Actual direct labour used was 91,000 hours at $12.10 per hour.

Required:

1. Calculate the direct materials price and usage variances.
2. Calculate the direct labour rate and efficiency variances.

3. Prepare the journal entries for the direct materials and direct labour variances.
4. Describe how flexible budgeting variances relate to the direct materials and direct labour variances computed in Requirements 1 and 2.

Exercise 9-20 INVESTIGATION OF VARIANCES

OBJECTIVE 3

Madison Company uses the following rule to determine whether direct labour efficiency variances ought to be investigated. A direct labour efficiency variance will be investigated if the amount exceeds the lesser of $12,000 or 10 percent of the standard labour cost. Reports for the past five weeks provided the following information:

Week	*LEV*	Standard Labour Cost
1	$14,000 F	$160,000
2	15,600 U	175,000
3	12,000 F	160,000
4	10,000 U	170,000
5	11,500 U	110,000

Required:

1. Using the rule provided, identify the cases that will be investigated.
2. Suppose that investigation reveals that the cause of an unfavourable direct labour efficiency variance is the use of lower-quality direct materials than are usually used. Who is responsible? What corrective action would likely be taken?
3. Suppose that investigation reveals that the cause of a significant favourable direct labour efficiency variance is attributable to a new approach to manufacturing that takes less labour time but causes more direct materials waste. Upon examining the direct materials usage variance, it is discovered to be unfavourable, and it is larger than the favourable direct labour efficiency variance. Who is responsible? What action should be taken? How would your answer change if the unfavourable variance were smaller than the favourable?

Exercise 9-21 OVERHEAD VARIANCES, FOUR-VARIANCE ANALYSIS, JOURNAL ENTRIES

OBJECTIVE 4

Laughlin Inc. uses a standard costing system. The predetermined overhead rates are calculated using practical capacity. Practical capacity for a year is defined as 1,000,000 units requiring 200,000 standard direct labour hours. Budgeted overhead for the year is $750,000, of which $300,000 is fixed overhead. During the year, 900,000 units were produced using 190,000 direct labour hours. Actual annual overhead costs totalled $800,000, of which $294,700 is fixed overhead.

Required:

1. Calculate the fixed overhead spending and volume variances. Explain the meaning of the volume variance to the manager of Laughlin.
2. Calculate the variable overhead spending and efficiency variances. Is the spending variance the same as the direct materials price variance? If not, explain how it differs.
3. Prepare the journal entries that reflect the following:
   a. Assignment of overhead to production.
   b. Recognition of the incurrence of actual overhead.
   c. Recognition of overhead variances.
   d. Closing out overhead variances, assuming they are immaterial.

Problems

Problem 9-22 STANDARD COSTS, DECOMPOSITION OF BUDGET VARIANCES, DIRECT MATERIALS AND DIRECT LABOUR

OBJECTIVE 2 3

Brodsky Corporation produces dress shirts. The company uses a standard costing system and has set the following standards for direct materials and direct labour (for one shirt):

Fabric (1.5 metres @ $2.40)	$ 3.60
Direct labour (1 hr @ $12)	12.00
Total prime cost	$15.60

During the year, Brodsky produced 6,800 shirts. The actual fabric purchased was 10,750 metres at $2.30 per metre. There were no beginning or ending inventories of fabric. Actual direct labour was 6,850 hours at $12.25 per hour.

Required:

1. Compute the costs of fabric and direct labour that should have been incurred for the production of 6,800 shirts.
2. Compute the total budget variances for direct materials and direct labour.
3. Break down the total budget variance for direct materials into a price variance and a usage variance. Prepare the journal entries associated with these variances.
4. Break down the total budget variance for direct labour into a rate variance and an efficiency variance. Prepare the journal entries associated with these variances.

OBJECTIVE 4

Problem 9-23 OVERHEAD APPLICATION, OVERHEAD VARIANCES, JOURNAL ENTRIES

Plimpton Company produces countertop ovens. Plimpton uses a standard costing system. The standard costing system relies on direct labour hours to assign overhead costs to production. The direct labour standard indicates that two direct labour hours should be used for every oven produced. The normal production volume is 100,000 units. The budgeted overhead for the coming year is as follows:

Fixed overhead	$770,000
Variable overhead	444,000*

*At normal volume.

During the year, Plimpton produced 97,000 units, worked 196,000 direct labour hours, and incurred actual fixed overhead costs of $780,000 and actual variable overhead costs of $435,600.

Required:

1. Calculate the standard fixed overhead rate and the standard variable overhead rate.
2. Compute the applied fixed overhead and the applied variable overhead. What is the total fixed overhead variance? Total variable overhead variance?
3. Break down the total fixed overhead variance into a spending variance and a volume variance. Discuss the significance of each.
4. Compute the variable overhead spending and efficiency variances. Discuss the significance of each.
5. Now assume that Plimpton's cost accounting system reveals only the total actual overhead. In this case, a three-variance analysis can be performed. Using the relationships between a three- and four-variance analysis, indicate the values for the three overhead variances.
6. Prepare the journal entries that would be related to fixed and variable overhead during the year and at the end of the year. Assume variances are closed to Cost of Goods Sold.

OBJECTIVE 3 4

Problem 9-24 DIRECT MATERIALS, DIRECT LABOUR, AND OVERHEAD VARIANCES, JOURNAL ENTRIES

Algiers Company produces dry fertilizer. At the beginning of the year, Algiers had the following standard cost sheet:

Direct materials (5 kg @ $2.60)	$13.00
Direct labour (0.75 hr @ $18.00)	13.50
Fixed overhead (0.75 hr @ $4.00)	3.00
Variable overhead (0.75 hr @ $3.00)	2.25
Standard cost per unit	$31.75

Algiers computes its overhead rates using practical volume, which is 54,000 units. The actual results for the year are as follows:

a. Units produced: 53,000
b. Direct materials purchased: 274,000 kilograms at $2.50 per kilogram
c. Direct materials used: 270,300 kilograms
d. Direct labour: 40,100 hours at $17.95 per hour
e. Fixed overhead: $161,700
f. Variable overhead: $122,000

Required:

1. Compute price and usage variances for direct materials.
2. Compute the direct labour rate and labour efficiency variances.
3. Compute the fixed overhead spending and volume variances. Interpret the volume variance.
4. Compute the variable overhead spending and efficiency variances.
5. Prepare journal entries for the following:
   a. The purchase of direct materials
   b. The issuance of direct materials to production (Work in Process)
   c. The addition of direct labour to Work in Process
   d. The addition of overhead to Work in Process
   e. The incurrence of actual overhead costs
   f. Closing out of variances to Cost of Goods Sold

Problem 9-25 SOLVING FOR UNKNOWNS

OBJECTIVE 2 3 4

Winnipeg Company uses a standard costing system. During the past quarter, the following variances were computed:

Variable overhead efficiency variance	$ 24,000 U
Direct labour efficiency variance	120,000 U
Direct labour rate variance	10,400 U

Winnipeg applies variable overhead using a standard rate of $2 per direct labour hour allowed. Two direct labour hours are allowed per unit produced. (Only one type of product is manufactured.) During the quarter, Winnipeg used 30 percent more direct labour hours than should have been used.

Required:

1. What were the actual direct labour hours worked? The total hours allowed?
2. What is the standard hourly rate for direct labour? The actual hourly rate?
3. How many actual units were produced?

Problem 9-26 BASIC VARIANCE ANALYSIS, REVISION OF STANDARDS, JOURNAL ENTRIES

OBJECTIVE 1 2 3 4

Nanaimo Company produces engine parts for large motors. The company uses a standard cost system for production costing and control. The standard cost sheet for one of its higher volume products (a valve) is as follows:

Direct materials (7 kg @ $5.40)	$37.80
Direct labour (1.75 hrs @ $18)	31.50
Variable overhead (1.75 hrs @ $4.00)	7.00
Fixed overhead (1.75 hrs @ $3.00)	5.25
Standard unit cost	$81.55

During the year, Nanaimo experienced the following activity relative to the production of valves:

a. Production of valves totalled 20,600 units.
b. A total of 135,400 kilograms of direct materials was purchased at $5.36 per kilogram.
c. There were 10,000 kilograms of direct materials in beginning inventory (carried at $5.40 per kilogram). There was no ending inventory.

d. The company used 36,500 direct labour hours at a total cost of $656,270.
e. Actual fixed overhead totalled $110,000.
f. Actual variable overhead totalled $168,000.

Nanaimo produces all of its valves in a single plant. Normal activity is 20,000 units per year. Standard overhead rates are computed based on normal activity measured in standard direct labour hours.

Required:

1. Compute the direct materials price and usage variances.
2. Compute the direct labour rate and efficiency variances.
3. Compute overhead variances using a two-variance analysis.
4. Compute overhead variances using a four-variance analysis.
5. Assume that the purchasing agent for the valve plant purchased a lower-quality direct material from a new supplier. Would you recommend that the company continue to use this cheaper direct material? If so, what standards would likely need revision to reflect this decision? Assume that the end product's quality is not significantly affected.
6. Prepare all possible journal entries (assuming a four-variance analysis of overhead variances).

OBJECTIVE ➤ 1 2 3 4

Problem 9-27 UNIT COSTS, MULTIPLE PRODUCTS, VARIANCE ANALYSIS, JOURNAL ENTRIES

Business Specialty Inc. manufactures two staplers: small and regular. The standard quantities of direct labour and direct materials per unit for the year are as follows:

	Small	Regular
Direct materials (100 g)	0.60	1.00
Direct labour (hrs)	0.1	0.15

The standard price paid per 100 grams of direct materials is $1.60. The standard rate for labour is $8.00. Overhead is applied on the basis of direct labour hours. A plantwide rate is used. Budgeted overhead for the year is as follows:

Budgeted fixed overhead	$360,000
Budgeted variable overhead	480,000

The company expects to work 12,000 direct labour hours during the year; standard overhead rates are computed using this activity level. For every small stapler produced, the company produces two regular staplers.

Actual operating data for the year are as follows:

a. Units produced: small staplers, 35,000; regular staplers, 70,000.
b. Direct materials purchased and used: 5,600,000 grams at $1.55 per 100 grams—1,300,000 for the small stapler and 4,300,000 for the regular stapler. There were no beginning or ending direct materials inventories.
c. Direct labour: 14,800 hours—3,600 hours for the small stapler and 11,200 hours for the regular stapler. Total cost of direct labour: $114,700.
d. Variable overhead: $607,500.
e. Fixed overhead: $350,000.

Required:

1. Prepare a standard cost sheet showing the unit cost for each product.
2. Compute the direct materials price and usage variances for each product. Prepare journal entries to record direct materials activity.
3. Compute the direct labour rate and efficiency variances for each product. Prepare journal entries to record direct labour activity.
4. Compute the variances for fixed and variable overhead. Prepare journal entries to record overhead activity. All variances are closed to Cost of Goods Sold.
5. Assume that you know only the total direct materials used for both products and the total direct labour hours used for both products. Can you compute the total direct materials and direct labour usage variances? Explain.

Problem 9-28 DIRECT MATERIALS USAGE VARIANCE, DIRECT MATERIALS MIX AND YIELD VARIANCES

OBJECTIVE 3 5

Vet-Pro Inc. produces a veterinary grade anti-anxiety mixture for pets with behavioural problems. Two chemical solutions, Aranol and Lendyl, are mixed and heated to produce a chemical that is sold to companies that produce the anti-anxiety pills. The mixture is produced in batches and has the following standards:

Direct Material	Standard Mix	Standard Unit Price	Standard Cost
Aranol	3,000 litres	$4.00 per litre	$ 12,000
Lendyl	17,000	6.00	102,000
Total	20,000 litres		$114,000
Yield	16,000 litres		

During March, the following actual production information was provided:

Direct Material	Actual Mix
Aranol	60,000 litres
Lendyl	140,000
Total	200,000 litres
Yield	166,000 litres

Required:

1. Compute the direct materials mix and yield variances.
2. Compute the total direct materials usage variance for Aranol and Lendyl. Show that the total direct materials usage variance is equal to the sum of the direct materials mix and yield variances.

Problem 9-29 DIRECT LABOUR EFFICIENCY VARIANCE, DIRECT LABOUR MIX AND YIELD VARIANCES

OBJECTIVE 3 5

Refer to the data in **Problem 9-28**. Vet-Pro Inc. also uses two different types of direct labour in producing the anti-anxiety mixture: mixing and drum-filling labour (the completed product is placed into 50-litre drums). For each batch of 20,000 litres of direct materials input, the following standards have been developed for direct labour:

Direct Labour Type	Mix	*SP*	Standard Cost
Mixing	2,000 hrs	$14.00	$28,000
Drum-filling	1,000	9.50	9,500
Total	3,000 hrs		$37,500
Yield	15,000 litres		

The actual direct labour hours used for the output produced in March are also provided:

Direct Labour Type	Mix
Mixing	18,000 hrs
Drum-filling	12,000
Total	30,000 hrs
Yield	158,400 litres

Required:

1. Compute the direct labour mix and yield variances.
2. Compute the total direct labour efficiency variance. Show that the total direct labour efficiency variance is equal to the sum of the direct labour mix and yield variances.

Problem 9-30 SOLVING FOR UNKNOWNS, OVERHEAD ANALYSIS

OBJECTIVE 3 4

Nuevo Company produces a single product. Nuevo employs a standard cost system and uses a flexible budget to predict overhead costs at various levels of activity. For the most

recent year, Nuevo used a standard overhead rate equal to $6.25 per direct labour hour. The rate was computed using expected activity. Budgeted overhead costs are $80,000 for 10,000 direct labour hours and $120,000 for 20,000 direct labour hours. During the past year, Nuevo generated the following data:

a. Actual production: 4,000 units
b. Fixed overhead volume variance: $1,750 U
c. Variable overhead efficiency variance: $3,200 F
d. Actual fixed overhead costs: $41,335
e. Actual variable overhead costs: $70,000

Required:

1. Determine the fixed overhead spending variance.
2. Determine the variable overhead spending variance.
3. Determine the standard hours allowed per unit of product.
4. Assuming the standard labour rate is $9.50 per hour, compute the direct labour efficiency variance.

OBJECTIVE 1 3 4

Problem 9-31 FLEXIBLE BUDGET, STANDARD COST VARIANCES, T-ACCOUNTS

Yakamoto Company manufactures external hard drives. At the beginning of the period, the following plans for production and costs were revealed:

Units to be produced and sold	25,000
Standard cost per unit:	
Direct materials	$10
Direct labour	8
Variable overhead	4
Fixed overhead	3
Total unit cost	$25

During the year, 24,800 units were produced and sold. The following actual costs were incurred:

Direct materials	$264,368
Direct labour	204,352
Variable overhead	107,310
Fixed overhead	73,904

There were no beginning or ending inventories of direct materials. The direct materials price variance was $10,168 unfavourable. In producing the 24,800 units, a total of 12,772 hours were worked, 3 percent more hours than the standard allowed for the actual output. Overhead costs are applied to production using direct labour hours.

Required:

1. Prepare a performance report comparing expected costs to actual costs.
2. Determine the following:
   a. Direct materials usage variance.
   b. Direct labour rate variance.
   c. Direct labour efficiency variance.
   d. Fixed overhead spending and volume variances.
   e. Variable overhead spending and efficiency variances.
3. Use T-accounts to show the flow of costs through the system. In showing the flow, you do not need to show detailed overhead variances. Show only the over- and underapplied variances for fixed and variable overhead.

OBJECTIVE 2 3

SERVICE

Problem 9-32 VARIANCE ANALYSIS IN A PROCESS-COSTING SETTING (CHAPTER 5 REQUIRED), SERVICE FIRM

Banff Medical Laboratory performs comprehensive blood tests for physicians and clinics throughout the Rockies. Banff uses a standard process-costing system for its

comprehensive blood work. Skilled technicians perform the blood tests. Because Banff uses a standard costing system, equivalent units are calculated using the FIFO method. The standard cost sheet for the blood test follows (these standards were used throughout the calendar year):

Direct materials (4 g @ $4.50)	$18
Direct labour (2 hrs @ $18.00)	36
Variable overhead (2 hrs @ $5.00)	10
Fixed overhead (2 hrs @ $10.00)	20
Standard cost per test	$84

For the month of November, Banff reported the following actual results:

a. Beginning work in process: 1,250 tests, 60 percent complete
b. Tests started: 25,000
c. Ending work in process: 2,500 tests, 40 percent complete
d. Direct labour: 47,000 hours at $19 per hour
e. Direct materials purchased and used: 102,000 at $4.25 per gram
f. Variable overhead: $144,000
g. Fixed overhead: $300,000
h. Direct materials are added at the beginning of the process.

Required:

1. Explain why the FIFO method is used for process costing when a standard costing system has been adopted.
2. Calculate the cost of goods transferred out (tests completed and transferred out) for the month of November. Does standard costing simplify process costing? Explain.
3. Calculate price and quantity variances for direct materials and direct labour.

CMA Problems

CMA Problem 9-1 SETTING STANDARDS, ETHICAL BEHAVIOUR*

OBJECTIVE 1 2

Borden Farms is a producer of items made from farm products that are distributed to supermarkets. For many years, Borden's products have had strong regional sales on the basis of brand recognition. However, other companies have been marketing similar products in the area, and price competition has become increasingly important. Doug Wang, the company's controller, is planning to implement a standard costing system for Borden and has gathered considerable information from his coworkers on production and direct materials requirements for Borden's products. Doug believes that the use of standard costing will allow Borden to improve cost control and make better operating decisions.

Borden's most popular product is strawberry jam. The jam is produced in 40-litre batches, and each batch requires six litres of good strawberries. The fresh strawberries are sorted by hand before entering the production process. Because of imperfections in the strawberries and spoilage, one litre of strawberries is discarded for every four litres of acceptable berries. Three minutes is the standard direct labour time required for sorting strawberries in order to obtain one litre of strawberries. The acceptable strawberries are then processed with the other ingredients: processing requires 12 minutes of direct labour time per batch. After processing, the jam is packaged in litre containers. Doug has gathered the following information from Pierre Arcand, Borden's cost accountant, relative to processing the strawberry jam.

a. Borden purchases strawberries at a cost of $0.80 per litre. All other ingredients cost a total of $0.1125 per litre.
b. Direct labour is paid at the rate of $9.00 per hour.
c. The total cost of direct material and direct labour required to package the jam is $0.38 per litre.

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Pierre has a friend who owns a strawberry farm that has been losing money in recent years. Because of good crops, there has been an oversupply of strawberries, and prices have dropped to $0.50 per litre. Pierre has arranged for Borden to purchase strawberries from his friend's farm in hopes that the $0.80 per litre will put his friend's farm in the black.

Required:

1. Discuss which coworkers Doug probably consulted to set standards. What factors should Doug consider in establishing the standards for direct materials and direct labour?
2. Develop the standard cost sheet for the prime costs of a 40-litre batch of strawberry jam.
3. Citing specific items in the CMA Code of Professional Ethics described in Chapter 1, explain why Pierre's behaviour regarding the cost information provided to Doug is unethical. *(CMA adapted)*

OBJECTIVE 3 5

CMA Problem 9-2 DIRECT MATERIALS USAGE VARIANCES, DIRECT MATERIALS MIX AND YIELD VARIANCES*

Energy Products Company produces a gasoline additive, Gas Gain. This product increases engine efficiency and improves gasoline mileage by creating a more complete burn in the combustion process.

Careful controls are required during the production process to ensure that the proper mix of input chemicals is achieved and that evaporation is controlled. If the controls are not effective, there can be a loss of output and efficiency.

The standard cost of producing a 500-litre batch of Gas Gain is $135. The standard direct materials mix and related standard cost of each chemical used in a 500-litre batch are as follows:

Chemical	Mix	*SP*	Standard Cost
Echol	200 litres	$0.200	$ 40.00
Protex	100	0.425	42.50
Benz	250	0.150	37.50
CT-40	50	0.300	15.00
Total	600 litres		$135.00

The quantities of chemicals purchased and used during the current production period are shown in the following schedule. A total of 140 batches of Gas Gain were manufactured during the current production period. Energy Products determines its cost and chemical usage variations at the end of each production period.

Chemical	Quantity Used
Echol	26,600 litres
Protex	12,880
Benz	37,800
CT-40	7,140
Total	84,420 litres

Required:

Compute the total direct materials usage variance, and then break down this variance into its mix and yield components. *(CMA adapted)*

OBJECTIVE 2 3

CMA Problem 9-3 STANDARD COSTING: PLANNED VARIANCES*

As part of its cost control program, Tracer Company uses a standard costing system for all manufactured items. The standard cost for each item is established at the beginning of the fiscal year, and the standards are not revised until the beginning of the next fiscal year. Changes in costs, caused during the year by changes in direct materials or direct labour inputs or by changes in the manufacturing process, are recognized as they occur by the inclusion of planned variances in Tracer's monthly operating budgets.

The following direct labour standard was established for one of Tracer's products, effective June 1, 2013, the beginning of the fiscal year:

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Assembler A labour (5 hrs @ $10)	$ 50
Assembler B labour (3 hrs @ $11)	33
Machinist labour (2 hrs @ $15)	30
Standard cost per 100 units	$113

The standard was based on the direct labour being performed by a team consisting of five persons with Assembler A skills, three persons with Assembler B skills, and two persons with machinist skills; this team represents the most efficient use of the company's skilled employees. The standard also assumed that the quality of direct materials that had been used in prior years would be available for the coming year.

For the first seven months of the fiscal year, actual manufacturing costs at Tracer have been within the standards established. However, the company has received a significant increase in orders, and there is an insufficient number of skilled workers to meet the increased production. Therefore, beginning in January, the production teams will consist of eight persons with Assembler A skills, one person with Assembler B skills, and one person with machinist skills. The reorganized teams will work more slowly than the normal teams, and as a result, only 80 units will be produced in the same time period in which 100 units would normally be produced. Faulty work has never been a cause for units to be rejected in the final inspection process, and it is not expected to be a cause for rejection with the reorganized teams.

Furthermore, Tracer has been notified by its direct materials supplier that lower-quality direct materials will be supplied beginning January 1. Normally, one unit of direct materials is required for each good unit produced, and no units are lost due to defective direct materials. Tracer estimates that 6 percent of the units manufactured after January 1 will be rejected in the final inspection process due to defective direct materials.

Required:

1. Determine the number of units of lower-quality direct materials that Tracer Company must enter into production in order to produce 47,000 good finished units.
2. How many hours of each class of direct labour must be used to manufacture 47,000 good finished units?
3. Determine the amount that should be included in Tracer's January operating budget for the planned direct labour variance caused by the reorganization of the direct labour teams and the lower-quality direct materials. *(CMA adapted)*

CMA Problem 9-4 SETTING STANDARDS, CALCULATING AND USING VARIANCES*

OBJECTIVE ➤ 1 3

Leather Works is a family-owned maker of leather travel bags and briefcases located in southwestern Ontario. Foreign competition has forced its owner, Heather Gray, to explore new ways to meet the competition. One of her cousins, Wallace Han, who recently graduated from university with a major in accounting, told her about the use of cost variance analysis to learn about efficiencies of production.

In May 2013, Heather asked Matt Jones, chief accountant, and Alfred Prideaux, production manager, to implement a standard costing system. Matt and Alfred, in turn, retained Shannon Leikam, a local accounting professor at Harding University, to set up a standard costing system by using information supplied to her by Matt's and Alfred's staff. To verify that the information was accurate, Shannon visited the plant and measured workers' output using time and motion studies. During those visits, she was not accompanied by either Matt or Alfred, and the workers knew about Shannon's schedule in advance. The cost system was implemented in June 2013.

Recently, the following dialogue took place among Heather, Matt, and Alfred:

HEATHER: How is the business performing?

ALFRED: You know, we are producing a lot more than we used to, thanks to the contract that you helped obtain from Lean Inc. for laptop covers. (Lean is a national supplier of computer accessories.)

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MATT: Thank goodness for that new product. It has kept us from sinking even more due to the inroads into our business made by those foreign suppliers of leather goods.

HEATHER: What about the standard costing system?

MATT: The variances are mostly favourable, except for the first few months when the supplier of leather started charging more.

HEATHER: How did the union members take to the standards?

ALFRED: Not bad. They grumbled a bit at first, but they have taken it in stride. We've consistently shown favourable direct labour efficiency variances and direct materials usage variances. The direct labour rate variance has been flat.

MATT: It should be since direct labour rates are negotiated by the union representative at the start of the year and remain the same for the entire year.

HEATHER: Matt, would you send me the variance report for laptop covers immediately?

The following chart summarizes the direct materials and direct labour variances from November 2013 through April 2014 (extracted from the report provided by Matt). Standards for each laptop cover are as follows:

a. One metre of direct materials at $22.50 per metre.
b. Forty-five minutes of direct labour at $14 per hour.

Month	Actual Cost (Direct Materials + Direct Labour)	Direct Materials Price Variance	Direct Materials Efficiency Variance	Direct Labour Rate Variance	Direct Labour Efficiency Variance
November	$150,000	$10,000 U	$5,000 F	$100 U	$5,000 F
December	155,000	11,000 U	5,200 F	110 U	6,500 F
January	152,000	10,100 U	4,900 F	105 U	7,750 F
February	151,000	9,900 U	4,500 F	95 U	6,950 F
March	125,000	9,000 U	3,000 F	90 U	8,200 F
April	115,000	8,000 U	2,000 F	90 U	8,500 F

In addition, the data for May 2014, but not the variances for the month, are as follows:

Laptop covers made in May	2,900 units
Total actual direct materials costs incurred	$68,850
Actual quantity of direct materials purchased and used	2,700 metres
Total actual direct labour cost incurred	$25,910.16
Total actual direct labour hours	1,837.6 hours

Actual direct labour cost per hour exceeded the budgeted rate by $0.10 per hour.

Required:

1. For May 2014, calculate the price and quantity variances for direct labour and direct materials.
2. Discuss the trend of the direct materials and labour variances.
3. What type of actions must the workers have taken during the period they were being observed for the setting of standards?
4. What can be done to ensure that the standards are set correctly? *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

- 1 Define responsibility accounting, and describe the four types of responsibility centres.
- 2 Explain why firms choose to decentralize.
- 3 Compute and explain return on investment (ROI), residual income (RI), and economic value added (EVA).
- 4 Discuss methods of evaluating and rewarding managerial performance.
- 5 Explain the role of transfer pricing in a decentralized firm.
- 6 Discuss the methods of setting transfer prices.

CHAPTER 10

Responsibility Accounting, Performance Evaluation, and Transfer Pricing

Responsibility Accounting

OBJECTIVE 1
Define responsibility accounting, and describe the four types of responsibility centres.

In general, companies are organized along lines of responsibility. The traditional pyramid-shaped organizational chart illustrates the lines of responsibility, which flow from the CEO through the vice presidents to middle and lower-level managers. As organizations grow larger, these lines of responsibility become longer and more numerous. There is a strong link between an organization's structure and its responsibility accounting system. Ideally, the responsibility accounting system mirrors and supports the structure of an organization.

Types of Responsibility Centres

As the firm grows, top management typically creates areas of responsibility known as responsibility centres and assigns subordinate managers to those areas. A **responsibility centre** is a part of the business whose manager is accountable for specified activities.

Responsibility accounting is a system that measures the results of each responsibility centre and compares those results with some expected or budgeted outcome. The four major types of responsibility centres are as follows:

1. **Cost centre:** A responsibility centre in which a manager is responsible only for costs.
2. **Revenue centre:** A responsibility centre in which a manager is responsible only for revenues.
3. **Profit centre:** A responsibility centre in which a manager is responsible for both revenues and costs.
4. **Investment centre:** A responsibility centre in which a manager is responsible for revenues, costs, and investments.

A production department within the factory, such as Assembly or Finishing, is an example of a cost centre. The supervisor of a production department does not set price or make marketing decisions, but can control manufacturing costs. Therefore, the production department supervisor is evaluated on the basis of how well costs are controlled.

The Marketing Department manager sets price and projected sales. Therefore, the Marketing Department may be evaluated as a revenue centre. Direct costs of the Marketing Department and overall sales are the responsibility of the sales manager.

In some companies, plant managers are responsible for pricing and selling products they manufacture. These plant managers control both costs and revenues, putting them in control of a profit centre. Operating income is an important performance measure for profit centre managers.

Finally, divisions are often cited as examples of investment centres. In addition to having control over cost and pricing decisions, divisional managers can make investment decisions, such as plant closings and openings, and decisions to keep or drop a product line. As a result, both operating income and some type of return on investment are important performance measures for investment centre managers.

It is important to realize that while the responsibility centre manager has responsibility for only the activities of that centre, decisions made by that manager can affect other responsibility centres. For example, the sales force at a floor care products firm routinely offers customers price discounts at the end of the month. Sales increase dramatically, but the factory is forced to put in overtime shifts to keep up with demand.

The Role of Information and Accountability

Information is the key to appropriately holding managers responsible for outcomes. For example, a production department manager is responsible for departmental costs but not for sales. This is because the production department manager not only controls some of these costs but also is best informed regarding them. Any deviation between actual and expected costs can best be explained at this level. Sales are the responsibility of the sales manager, because this manager understands and can explain price and quantity sold.

The management accountant has an expanded role in the development of a responsibility accounting system in the global business environment. Business looks to the accountant for financial and business expertise. The accountant's job is not cut and dried. Knowledge, creativity, and flexibility are needed to help managers make decisions. Good training, education, and staying up to date with one's field are important to any accountant. However, the job of the accountant in the international firm is made more challenging by the ambiguous and ever-changing nature of global business. Since much of the accountant's job is to provide relevant information to management, staying up to date requires reading in a variety of business areas, including information systems, marketing, management, politics, and economics. In addition, the accountant must be familiar with the financial accounting rules of the countries in which the firm operates.

Responsibility also entails accountability. Accountability implies performance measurement, which means that actual outcomes are compared with expected or budgeted outcomes. This system of responsibility, accountability, and performance evaluation is often referred to as *responsibility accounting* because of the key role that accounting measures and reports play in the process.

Decentralization

OBJECTIVE 2
Explain why firms choose to decentralize.

Firms with multiple responsibility centres choose one of two approaches to manage their diverse and complex activities: centralized decision making or decentralized decision making. In **centralized decision making**, decisions are made at the very top level, and lower-level managers are charged with implementing these decisions. On the other hand, **decentralized decision making** allows managers at lower levels to make and implement key decisions pertaining to their areas of responsibility. **Decentralization** is the practice of delegating decision-making authority to the lower levels.

Organizations range from highly centralized to strongly decentralized. Although some firms lie at either end of the continuum, most fall somewhere between the two extremes, with the majority of these tending toward a decentralized approach. A special case of the decentralized firm is the **multinational corporation (MNC)**. The MNC is a corporation that "does business in more than one country in such a volume that its well-being and growth rest in more than one country."[1]

Reasons for Decentralization

There are seven main reasons for delegating decision-making authority to lower levels of management.

1. Better Access to Local Information Decision quality is affected by the quality of information available. Lower-level managers who are in contact with immediate operating conditions (e.g., the strength and nature of local competition, the nature of the local labour force, and so on) have better access to local information. As a result, local managers are often in a position to make better decisions. This advantage of decentralization is particularly applicable to multinational corporations, where far-flung divisions may be operating in a number of different countries, subject to various legal systems and customs.

2. Cognitive Limitations Even if central management had good local information, those managers would face another problem. In a large, complex organization that operates in diverse markets with hundreds or thousands of different products, no one person has all of the expertise and training needed to process and use the information. Cognitive limitation means that individuals with specialized skills would still be needed. Rather than having different individuals at headquarters for every specialized area, why not let these individuals have direct responsibility in the field? In this way, the firm can avoid the cost and bother of collecting and transmitting local information to headquarters. The structure of Canadian business is changing. No longer are middle managers individuals with "people skills" and organization skills only. They must have specific fields of expertise in addition to managerial talent. For example, a middle manager in a bank may refer to herself as a financial specialist even though she manages 20 people. The capability to add skilled expertise is seen as crucial in today's downsized environment.

[1] Yair Aharoni, "On the Definition of a Multinational Corporation," in A. Kapoor and Phillip D. Grub, eds., *The Multinational Enterprise in Transition* (Princeton, NJ: Darwin Press, 1972): 4.

3. More Timely Response In a centralized setting, it takes time to transmit local information to headquarters and then transmit the decision back to the local unit. These two transmissions cause delay and increase the potential for miscommunication, decreasing the effectiveness of the response. In a decentralized organization, where the local manager both makes and implements the decision, this problem does not arise.

Local managers in the MNC are able to respond quickly to customer discount demands, local government demands, and changes in the political climate. The different languages native to managers of divisions in the MNC make miscommunication an even greater problem. MNCs address this problem in two ways. First, a decentralized structure pushes decision making down to the local manager level, eliminating the need to interpret instructions from above. Second, MNCs are learning to incorporate technology that overrides the language barrier and eases cross-border data transfer. Technology is of great help in smoothing communication difficulties between parent and subsidiary and between one subsidiary and another.

4. Focusing of Central Management Managers at higher levels of the hierarchical pyramid have broader responsibilities and powers. By decentralizing the operating decisions, central management is free to focus on strategic planning and decision making. Central management can concentrate on the long-run survival of the organization rather than day-to-day operations.

5. Training and Evaluation of Segment Managers An organization always needs well-trained managers to replace higher-level managers who retire or move on to other opportunities. By decentralizing, lower-level managers are given opportunities to make and implement decisions. What better way to prepare a future generation of higher-level managers than by giving them the chance to make significant decisions? This also enables top managers to evaluate the local manager's capabilities, so that those who make the best decisions can be promoted to central management.

Just as decentralization gives the lower-level managers in the home country a chance to develop managerial skills, foreign subsidiary managers also gain valuable experience. Additionally, home country managers gain broader experience by interacting with managers of foreign divisions. The chance to learn from one another is much greater in a decentralized MNC. Off and on throughout the past 50 years, a tour of duty at a foreign subsidiary has been a part of the manager's climb to the top. Now, foreign subsidiary managers may expect to spend some time at headquarters in the home office, as well.

6. Motivation of Segment Managers By giving local managers freedom to make decisions, some of their higher-level needs (self-esteem and self-actualization) are being met. Greater responsibility can produce more job satisfaction and motivate the local manager to work harder. Initiative and creativity are encouraged. Of course, the extent to which the motivational benefits can be realized depends to a large degree on how managers are evaluated and rewarded for their performance.

7. Enhanced Competition In a highly centralized company, large overall profit margins can mask inefficiencies within the various subdivisions. A decentralized approach allows the company to determine each division's contribution to profit and to expose each division to market forces.

The Units of Decentralization

Decentralization is usually achieved by segmenting the company into *divisions*. One way in which divisions are differentiated is by the types of goods or services produced.

For example, **Armstrong World Industries, Inc.** has four product divisions: floor coverings (resilient sheet and tile); building products (acoustical ceilings and wall panels); industry products (insulation for heating, cooling, plumbing, and refrigeration systems); and ceramic tile. **PepsiCo** divisions include the **PepsiCo Americas**

Beverages (including **SoBe**, **Tropicana**, **Gatorade**, and **Aquafina Water**, as well as its flagship soft drink division), **PepsiCo Americas Foods** (including **Frito-Lay**, **Quaker Foods & Snacks**, **Sabritas**, **Gamesa**, and **Latin America Foods**), and **PepsiCo International**. Some divisions depend on other divisions. For example, PepsiCo spun off **KFC**, **Taco Bell**, and **Pizza Hut** into **Yum Brands**. In these restaurants, the cola you purchase will be Pepsi—not Coke.

In a decentralized setting, some interdependencies usually exist; otherwise, a company would merely be a collection of totally separate entities. The presence of these interdependencies creates the need for transfer pricing, which is discussed later in this chapter.

Similarly, companies create divisions according to the type of customer served.

Wal-Mart has five retail divisions. The Wal-Mart stores division targets discount store customers. The supercentre division targets customers of Wal-Mart's supercentre stores, which sell a variety of food, drug, and household items. **Sam's Club** focuses on buyers for small business. **Wal-Mart Neighborhood Markets** offer smaller convenience stores. Finally, the international division concentrates on global opportunities.

Organizing divisions as responsibility centres differentiates them on the degree of decentralization and creates opportunities to control them through responsibility accounting. Control of cost centres is achieved by evaluating the efficiency and the effectiveness of divisional managers. **Efficiency** means how well activities are performed; it might be measured by the number of units produced per hour or by the cost of those units. **Effectiveness** can be defined as whether the manager has performed the right activities. Measures of effectiveness might focus on value-added versus non-value-added activities.

Measuring Divisional Performance of Investment Centres

OBJECTIVE 3
Compute and explain return on investment (ROI), residual income (RI), and economic value added (EVA).

Companies maintain control of responsibility centres by developing performance measures for each centre and basing rewards on a manager's ability to control the responsibility centre.

Performance measures are developed to provide some direction for managers of decentralized divisions and to evaluate their performance. The development of performance measures and the specification of a reward structure are major issues for a decentralized organization. Because performance measures can affect the behaviour of managers, the measures chosen should encourage goal congruence. **Goal congruence** means that the goals of the manager are closely aligned with the goals of the firm. Well-chosen performance measures influence managers to pursue the company's objectives. Three performance evaluation measures for investment centres are return on investment, residual income, and economic value added.

Return on Investment

While divisional net income could be used to rank the divisions of a company, it may provide misleading information about segment performance. For example, suppose that two divisions report profits of $100,000 and $200,000, respectively. Is the second division performing better than the first? What if the first division used an investment of $500,000 to produce the contribution of $100,000, while the second used an investment of $2 million to produce the $200,000 contribution? Clearly, relating the reported operating profits to the assets used to produce them is a more meaningful measure of performance.

One way to relate operating profits to assets employed is to compute the profit earned per dollar of investment. For example, the first division earned $0.20 per dollar invested ($100,000/$500,000); the second division earned only $0.10 per dollar invested ($200,000/$2,000,000). In percentage terms, the first division

provides a 20 percent rate of return and the second division, 10 percent. This method of computing the relative profitability of investments is known as the return on investment.

Return on investment (ROI) is the most common measure of performance for an investment centre. It is useful both externally and internally. Externally, ROI is used by shareholders to indicate the health of a company. Internally, ROI is used to measure the relative performance of divisions.

ROI can be defined in the following three ways:

$$\begin{aligned}\text{ROI} &= \text{Operating income/Average operating assets}\\ &= \text{Operating income/Sales} \times \text{(Sales/Average operating assets)}\\ &= \text{Operating income margin} \times \text{Operating asset turnover}\end{aligned}$$

Operating income refers to earnings before interest and income taxes and is typically used for divisions. Net income is used in the calculation of ROI for the company as a whole. **Operating assets** include all assets used to generate operating income. They usually include cash, receivables, inventories, land, buildings, and equipment. Average operating assets is computed as follows:

$$\text{Average operating assets} = \text{(Beginning net book value} + \text{Ending net book value)/2}$$

Opinions vary regarding how long-term assets (plant and equipment) should be valued (e.g., gross book value versus net book value or historical cost versus current cost). Most firms use historical cost net book value.[2] Cornerstone 10-1 shows the how and why of calculating average operating assets, margin, turnover, and return on investment.

Margin and Turnover The ROI formula is broken into two component ratios: *margin* and *turnover*. **Margin** is the ratio of operating income to sales. It shows the portion of sales that is available for interest, income taxes, and profit. **Turnover** is a different measure; it is found by dividing sales by average operating assets. The result shows how productively assets are being used to generate sales.

Both measures can affect ROI. Let's examine the relationship of margin, turnover, and ROI more closely by considering Cornerstone 10-1. Both divisions have the same return on investment, 18 percent. However, the Snack Foods Division has a margin of 6 percent versus the Appliance Division margin of 3 percent. This tells us that the Snack Foods Division earns twice as much per dollar of sales than the Appliance Division. However, the Appliance Division has higher turnover, indicating that it is using its operating assets more effectively than the Snack Foods Division. That is, it takes fewer dollars of assets to support every dollar of income earned.

Consider a second year of data for each of the two divisions:

	Snack Foods Division	Appliance Division
	Year 2	Year 2
Sales	$40,000,000	$117,000,000
Operating income	$2,000,000	$2,925,000
Average operating assets	$10,000,000	$19,500,000
Margin	5%	2.5%
Turnover	4.0	6.0
ROI	20%	15%

The Snack Foods Division improved its ROI from 18 percent to 20 percent from Year 1 to Year 2, while the Appliance Division's ROI dropped from 18 percent to 15 percent. Notice that the margins for both divisions dropped from Year 1 to Year 2. A declining margin could be explained by increasing expenses, by competitive pressures (forcing a decrease in selling prices), or both.

[2] For a discussion of the relative merits of gross book value, see James S. Reese and William R. Cool, "Measuring Investment Centre Performance," *Harvard Business Review* (May–June 1978): 28–46, 174–176.

The HOW and WHY of Calculating Average Operating Assets, Margin, Turnover, and Return on Investment (ROI)

CORNERSTONE 10-1

Information:

Multidiv Inc. provided the following information for two of its divisions for last year:

	Snack Foods Division	Appliance Division
Sales	$30,000,000	$117,000,000
Operating income	1,800,000	3,510,000
Operating assets, January 1	9,600,000	17,500,000
Operating assets, December 31	10,400,000	21,500,000

Why:

Return on investment is a key measure of performance. It relates the income earned to the investment needed to produce that income. It is appropriate for companies and for investment centres.

Required:

1. For the Snack Foods Division, calculate:
   a. Average operating assets
   b. Margin
   c. Turnover
   d. Return on investment (ROI)
2. For the Appliance Division, calculate:
   a. Average operating assets
   b. Margin
   c. Turnover
   d. Return on investment (ROI)
3. ***What if*** ending assets for the Snack Foods Division were $14,400,000? How would that affect average operating assets? Margin? Turnover? ROI?

Solution:

1. a. Average operating assets = (Beginning assets + Ending assets)/2
   = ($9,600,000 + $10,400,000)/2
   = $10,000,000

   b. Margin = Operating income/Sales
   = $1,800,000/$30,000,000
   = 0.06, or 6%

   c. Turnover = Sales/Average operating assets
   = $30,000,000/$10,000,000
   = 3.0

   d. ROI = Margin × Turnover
   = 0.06 × 3.0
   = 0.18, or 18%

   OR

   ROI = Operating income/Average operating assets
   = $1,800,000/$10,000,000
   = 0.18, or 18%

CORNERSTONE 10-1 *(continued)*

2. a. Average operating assets = (Beginning assets + Ending assets)/2
= ($17,500,000 + $21,500,000)/2
= $19,500,000

b. Margin = Operating income/Sales
= $3,510,000/$117,000,000
= 0.03, or 3%

c. Turnover = Sales/Average operating assets
= $117,000,000/$19,500,000
= 6.0

d. ROI = Margin × Turnover
= 0.03 × 6.0
= 0.18, or 18%

OR

ROI = Operating income/Average operating assets
= $3,510,000/$19,500,000
= 0.18, or 18%

3. If ending operating assets for the Snack Foods Division were $14,400,000, then the average operating assets would be higher. Higher average operating assets leads to lower turnover and lower ROI. Margin would not be affected. New amounts would be:

Average operating assets = ($9,600,000 + $14,400,000)/2 = $12,000,000
Turnover = $30,000,000/$12,000,000 = 2.5
ROI = 0.06 × 2.5 = 0.15, or 15%

Despite the declining margin, the Snack Foods Division increased its rate of return. This increase resulted from an increase in the turnover rate that more than compensated for the decline in margin. The increase in turnover could be explained by a deliberate policy to reduce inventories (the average assets remained the same for the Snack Foods Division even though sales increased by $10 million).

The Appliance Division, on the other hand, had lower ROI because margin declined and the turnover rate stayed constant. Although more information is needed before any definitive conclusion is reached, the different responses to similar difficulties may say something about the relative skills of the two managers.

Advantages of the ROI Measure When ROI is used to evaluate performance, division managers naturally try to increase it. This can be accomplished by increasing sales, decreasing costs, and/or decreasing investment. Three advantages of using ROI are as follows:

1. It encourages investment centre managers to pay careful attention to the relationships among sales, expenses, and investment.
2. It encourages cost efficiency.
3. It discourages excessive investment in operating assets.

Each of these three advantages is discussed in turn.

The first advantage is that ROI encourages managers to consider the interrelationship of income and investment. Suppose that a division manager is faced with

the suggestion from her marketing vice president that the advertising budget be increased by $100,000. The marketing vice president is confident that this will boost sales by $200,000 and raise the contribution margin by $110,000. If the division were evaluated on the basis of operating income, this information is enough. However, if the division is evaluated on the basis of ROI, the manager will want to know how much additional investment is required to support the increased production and sales. Suppose that an additional $50,000 of operating assets will be needed. Currently, the division has sales of $2 million, operating income of $150,000, and operating assets of $1 million. Current ROI is 15 percent ($150,000/$1,000,000).

If advertising increased by $100,000 and the contribution margin by $110,000, operating income would increase by $10,000 ($110,000 − $100,000). Investment in operating assets must also increase by $50,000. With the additional advertising, the ROI is 15.24 percent ($160,000/$1,050,000). Since the ROI is increased by the proposal, the divisional manager should increase advertising.

The second advantage is that ROI encourages cost efficiency. The manager of an investment centre always has control over costs. Therefore, increasing efficiency through judicious cost reduction is a common method of increasing ROI. For example, decreasing non-value-added activities is a good way to decrease cost without decreasing production, sales, or quality. (Chapter 14 explains this in more detail.) There are ways to decrease costs in the short run that have a harmful effect on the business. This possibility is discussed in the section on disadvantages of ROI.

The third advantage is that ROI encourages efficient investment. Divisions that have cut costs to the extent possible must focus on investment reduction. For example, operating assets can be trimmed through the reduction of materials inventory and work-in-process inventory, perhaps by installing just-in-time purchasing and manufacturing systems. New, more productive machinery can be installed, inefficient plants can be closed, and so on. Companies are taking a hard look at their level of investment and acting to reduce it. This is a positive result of ROI-based evaluation.

Disadvantages of the ROI Measure The use of ROI to evaluate performance also has disadvantages. Two negative aspects associated with ROI are frequently mentioned.

1. It discourages managers from investing in projects that would decrease the divisional ROI but would increase the profitability of the company as a whole. (Generally, projects with an ROI less than a division's current ROI would be rejected.)
2. It can encourage myopic behaviour, in that managers may focus on the short run at the expense of the long run.

The first disadvantage can be illustrated by an example. Suppose that the Snack Foods Division has the opportunity to invest in two projects for the coming year. The first project is a new cheese-coated corn chip that requires additional factory space and special coating machinery. The second project is star-shaped corn chips. That project will require special extruding machinery to create the desired shapes. The outlay required for each investment, the dollar returns, and the ROI are as follows:

	Project I	Project II
Investment	$10,000,000	$4,000,000
Operating income	$1,500,000	$760,000
ROI	15%	19%

The division is currently earning an ROI of 18 percent, using operating assets of $10 million to generate operating income of $1.8 million. Corporate headquarters will approve up to $15 million in new investment capital and requires that all investments earn at least 12 percent. Any capital not used by a division is invested by headquarters so that it earns exactly 12 percent.

The divisional manager has four alternatives: (a) add Project I, (b) add Project II, (c) add both Projects I and II, and (d) maintain the status quo (invest in neither project). The divisional ROI has been computed for each alternative.

	Add Project I	Add Project II	Add Both Projects	Maintain Status Quo
Operating income	$3,300,000	$2,560,000	$4,060,000	$1,800,000
Operating assets	$20,000,000	$14,000,000	$24,000,000	$10,000,000
ROI	16.50%	18.29%	16.92%	18.00%

The divisional manager chooses to invest only in Project II, since it will have a favourable effect on the division's ROI (18.29 percent is greater than 18.00 percent).

Assuming that any capital not used by the division is invested at 12 percent, the manager's choice will produce a lower profit for the company than could have been realized. If Project I had been selected, the company would have earned $1.5 million. By not selecting Project I, the $10 million in capital is invested at 12 percent, earning only $1.2 million (0.12 × $10,000,000). By maximizing the division's ROI, then, the divisional manager cost the company $300,000 in profits ($1,500,000 – $1,200,000).

The second disadvantage of using ROI to evaluate performance is that it can encourage myopic behaviour. An advantage of ROI is that it encourages cost reduction. However, while cost reduction can result in more efficiency, it can also result in lower efficiency in the long run. The emphasis on short-run results at the expense of the long run is **myopic behaviour**. Examples are laying off more highly paid employees, cutting the advertising budget, delaying promotions and employee training, reducing preventive maintenance, and using cheaper materials.

Each of these steps reduces expenses, increases income, and raises ROI. While these actions increase profits and ROI in the short run, they have some long-run negative consequences. Laying off more highly paid salespeople may hurt the division's future sales. For example, it has been estimated that the average monthly cost of replacing a sales representative with five to eight years' experience with a representative with less than one year of experience is $36,000 of lost sales. Low employee turnover has been linked to high customer satisfaction.[3] Future sales could also be harmed by cutting back on advertising and using cheaper materials. By delaying promotions, employee morale will be affected, which can, in turn, lower productivity and future sales. Finally, reducing preventive maintenance will likely cut into the productive capability of the division by increasing downtime and decreasing the life of the productive equipment. While these actions raise current ROI, they lead to lower future ROI.

Residual Income

To avoid managers using ROI to turn down investments that are profitable for the company but that lower a division's ROI, some companies have adopted an alternative performance measure known as *residual income*. **Residual income** is the difference between operating income and the minimum dollar return required on a company's operating assets:

$$\text{Residual income} = \text{Operating income} - (\text{Minimum rate of return} \times \text{Operating assets})$$

Cornerstone 10-2 shows the how and why of calculating residual income.

Cornerstone 10-2 shows that the residual incomes of the two divisions are different, even though their ROIs are the same. Clearly, Multidiv earns more from the larger Appliance Division than it does from the Snack Foods Division.

[3] James L. Heskett, Thomas O. Jones, Gary W. Loveman, W. Earl Sasser, Jr., and Leonard A. Schlesinger, "Putting the Service-Profit Chain to Work," *Harvard Business Review* 74, 2 (March/April 1994): 164–174.

The HOW and WHY of Calculating Residual Income

CORNERSTONE 10-2

Information:

Multidiv Inc. provided the following information for two of its divisions for last year:

	Snack Foods Division	Appliance Division
Sales	$30,000,000	$117,000,000
Operating income	1,800,000	3,510,000
Average operating assets	10,000,000	19,500,000

Multidiv Inc. requires a 12 percent minimum rate of return.

Why:

Residual income is measured in dollar amounts rather than percentages. It relates the income earned to the minimum required return on investment and overcomes the tendency for managers to turn down profitable projects that might lower divisional ROI.

Required:

1. Calculate residual income for the Snack Foods Division.
2. Calculate residual income for the Appliance Division.
3. ***What if*** the minimum required rate of return was 16 percent? How would that affect the residual income of the two divisions?

Solution:

1. Residual income = Operating income − (Minimum rate of return × Operating assets)
   = $1,800,000 − (0.12 × $10,000,000)
   = $600,000
2. Residual income = Operating income − (Minimum rate of return × Operating assets)
   = $3,510,000 − (0.12 × $19,500,000)
   = $1,170,000
3. If the minimum rate of return was 16 percent, the residual income of both divisions would be lower.

   Snack Foods residual income = $1,800,000 − (0.16 × $10,000,000) = $200,000

   Appliance residual income = $3,510,000 − (0.16 × $19,500,000) = $390,000

Advantages of Residual Income Residual income is a dollar measure of performance. Even though the percentage rate of return is a familiar format for managers, and takes away the impact of size from the measure, at the end of the day, the dollar income does count. A manager can become so focused on the return on investment that profitable projects that return more than their cost of capital may be rejected. Residual income refocuses the manager on the profit.

To illustrate the use of residual income, consider the Snack Foods Division example again. Recall that the division manager rejected Project I because it would have reduced divisional ROI, which cost the company $300,000 in profits. The use of residual income as the performance measure would have prevented this loss. The residual income for each project is computed below.

Project I:

$$\begin{aligned}\text{Residual income} &= \text{Operating income} - (\text{Minimum rate of return} \times \text{Operating assets})\\ &= \$1{,}500{,}000 - (0.12 \times \$10{,}000{,}000)\\ &= \$300{,}000\end{aligned}$$

Project II:

$$\begin{aligned}\text{Residual income} &= \text{Operating income} - (\text{Minimum rate of return} \times \text{Operating assets})\\ &= \$760{,}000 - (0.12 \times \$4{,}000{,}000)\\ &= \$280{,}000\end{aligned}$$

Notice that both projects increase residual income; in fact, Project I increases the division's residual income more than Project II does. Thus, both would be selected by the divisional manager. For comparative purposes, the divisional residual income for each of the four alternatives identified earlier follows:

	Add Project I	Add Project II	Add Both Projects	Maintain Status Quo
Operating assets	$20,000,000	$14,000,000	$24,000,000	$10,000,000
Operating income	$ 3,300,000	$ 2,560,000	$ 4,060,000	$ 1,800,000
Minimum return*	2,400,000	1,680,000	2,880,000	1,200,000
Residual income	$ 900,000	$ 880,000	$ 1,180,000	$ 600,000

*Minimum return = 0.12 × Operating assets.

When residual income is used as the performance measure, both projects are clearly profitable and will be chosen. Managers are encouraged to move beyond a focus on the percentage return on investment to look at the absolute dollar value of the additional profit.

Disadvantages of Residual Income Two disadvantages of residual income are that it is an absolute measure of return and that it does not discourage myopic behaviour. Absolute measures of return make it difficult to directly compare the performance of divisions. For example, consider the residual income computations for Division A and Division B, where the minimum required rate of return is 8 percent.

	Division A	Division B
Average operating assets	$15,000,000	$2,500,000
Operating income	$ 1,500,000	$ 300,000
Minimum return[a]	1,200,000	200,000
Residual income	$ 300,000	$ 100,000
Residual return[b]	2%	4%

[a] 0.08 × Operating assets.
[b] Residual income divided by operating assets.

At first, it is tempting to claim that Division A outperforms Division B, since its residual income is three times higher. Notice, however, that Division A used six times as many assets to produce this difference. If anything, Division B is more efficient.

One possible way to correct this disadvantage is to compute a residual return on investment by dividing residual income by average operating assets. This measure indicates that Division B earned 4 percent while Division A earned only 2 percent. Another possibility is to compute both return on investment and residual income and use both measures for performance evaluation. ROI could then be used for interdivisional comparisons.[4]

[4] In their study, Reese and Cool found that only 2 percent of the companies surveyed used residual income by itself, whereas 28 percent used both residual income and return on investment. See Reese and Cool, "Measuring Investment Centre Performance."

The second disadvantage of residual income is that it can encourage a short-run orientation. Just as a manager can choose to cut maintenance, training, and sales force expenses when being evaluated under ROI, the manager being evaluated on the basis of residual income can take the same actions. The problem of myopic behaviour is not solved by switching to this measure. A preferable method of reducing the myopic behaviour problem of residual income is the economic value added method, discussed next.

Economic Value Added

Another measure of profitability for performance evaluation of investment centres is *economic value added*.[5] **Economic value added (EVA)** is after-tax operating income minus the total annual cost of capital. If EVA is positive, the company is creating wealth. If it is negative, then the company is destroying wealth. Over the long term, only those companies creating capital, or wealth, can survive. Many companies today use EVA to adjust management compensation; EVA encourages managers to use existing and new capital for maximum gain. **The Coca-Cola Company**, **General Electric**, and **Intel**, a few of the companies that have seen increasing EVA during the past 15 years.[6]

EVA is a dollar figure, not a percentage rate of return. However, it does bear a resemblance to rates of return such as ROI because it links net income (return) to capital employed. The key feature of EVA is its emphasis on *after-tax* operating income and the *actual* cost of capital. Other return measures may use accounting book value numbers which may or may not represent the true cost of capital. Residual income, for example, typically uses a minimum expected rate of return. Investors like EVA because it relates profit to the amount of resources needed to achieve it.

Calculating EVA EVA is after-tax operating income minus the dollar cost of capital employed. The equation for EVA is expressed as follows:

$$\text{EVA} = \text{After-tax operating income} - (\text{Weighted average cost of capital} \times \text{Total capital employed})$$

The difficulty faced by most companies is computing the cost of capital employed. Two steps are involved: (1) determine the **weighted average cost of capital** (a percentage figure) and (2) determine the total dollar amount of capital employed.

To calculate the weighted average cost of capital, the company must identify all sources of invested funds. Typical sources are borrowing and equity (stock issued). Typically, borrowed money has an interest rate attached, and that rate is adjusted for its tax deductibility. For example, if a company issued 10-year bonds at an annual interest rate of 8 percent and the tax rate is 40 percent, then the after-tax cost of the bonds is 4.8 percent [$0.08 - (0.4 \times 0.08)$]. Equity is handled differently. The cost of equity financing is the opportunity cost to investors. Over time, shareholders have received an average return that is six percentage points higher than the return on long-term government bonds. If these bond rates are about 6 percent, then the average cost of equity is 12 percent (6% + 6%). Riskier stocks command a higher return; more stable and less risky stocks offer a somewhat lower return. Finally, the proportionate share of each method of financing is multiplied by its percentage cost and summed to yield the total dollar amount of capital employed.

Suppose that a company has two sources of financing: $2 million of long-term bonds paying 9 percent interest and $6 million of common stock, which is considered to be of average risk. If the company's tax rate is 35 percent and the rate of interest on long-term government bonds is 3 percent, the company's weighted average cost of capital is computed as follows:

[5] EVA® is a registered trademark of Stern Stewart & Co.

[6] Richard Teitelbaum, "America's Greatest Wealth Creators," *Fortune* (November 10, 1997): 265–276; and Tad Leahy, "Measures of the Future," *Business Finance*, (February 1999), http://businessfinancemag.com/article/measures-future-editorial-supplement-appraising-value-finance-0201.

	Amount	Percent	×	After-Tax Cost	=	Weighted Cost
Bonds	$2,000,000	0.25		0.09(1 − 0.35) = 0.0585		0.0146
Equity	6,000,000	0.75		0.06 + 0.03 = 0.090		0.0675
Total	$8,000,000					0.0821

Thus, the company's weighted average cost of capital is 8.21 percent.

Next we need to know the amount of capital employed. Clearly, the amount paid for buildings, land, and machinery must be included. However, other expenditures meant to have a long-term payoff, such as research and development, employee training, and so on, should also be included. Despite the fact that the latter are classified by GAAP as expenses, EVA is an internal management accounting measure, and therefore, these expenses can be thought of as the investments that they truly are. Cornerstone 10-3 shows the how and why of calculating the weighted average cost of capital, the total dollar amount of capital employed, and EVA.

Behavioural Aspects of EVA Some companies have found that EVA helps to encourage the right kind of behaviour from their divisions in a way that emphasis on operating income alone cannot. The underlying reason is EVA's reliance on the true cost of capital. In many companies, the responsibility for investment decisions rests with corporate management. As a result, the cost of capital is considered a corporate expense. If a division builds inventories and investment, the cost of financing that investment is passed on to the overall income statement and does not reduce the division's operating income. Investment seems free to the divisions, and of course, they want more. As a result, EVA should be measured for subsets of the company.

Suppose that Supertech Inc. has two divisions, the Hardware Division and the Software Division. Operating income statements for the divisions are as follows:

	Hardware Division	Software Division
Sales	$5,000,000	$2,000,000
Cost of goods sold	2,000,000	1,100,000
Gross profit	3,000,000	900,000
Divisional selling and administrative expenses	2,000,000	400,000
Operating income	$1,000,000	$ 500,000

It looks as if the Hardware Division is doing a good job, and so is Software. Now, consider each division's use of capital. Suppose that Supertech's weighted average cost of capital is 11 percent. Hardware, by increasing inventories of components and finished goods, use of warehouses, and so on, uses capital amounting to $10 million, so its dollar cost of capital is $1,100,000 (0.11 × $10,000,000). Software does not need large materials inventories, but it does invest heavily in training and research and development. Its capital usage is $2 million, and its total dollar cost of capital is $220,000 (0.11 × $2,000,000). The EVA for each division can be calculated as follows:

	Hardware Division	Software Division
Operating income	$1,000,000	$500,000
Less: Cost of capital	1,100,000	220,000
EVA	$ (100,000)	$280,000

Now, it is clear that the Hardware Division is actually losing money by using too much capital. The Software Division, on the other hand, has created wealth for Supertech. By using EVA, the Hardware Division's manager will no longer

The HOW and WHY of Calculating the Weighted Average Cost of Capital and EVA

CORNERSTONE 10-3

Information:

Furman Inc. had after-tax operating income last year of $1,583,000. Three sources of financing were used by the company: $2 million of mortgage bonds paying 8 percent interest, $3 million of unsecured bonds paying 10 percent interest, and $10 million in common stock, which was considered to be no more or less risky than other stocks. (Over time, shareholders have received an average return that is six percentage points higher than the return on long-term government bonds.) The rate of return on long-term treasury bonds is 6 percent. Furman Inc. pays a marginal tax rate of 40 percent.

Why:

Economic value added adjusts earnings by the true cost of capital employed. As a result, it is a measure of wealth created or destroyed by a company.

Required:

1. Calculate the after-tax cost of each method of financing.
2. Calculate the weighted average cost of capital for Furman Inc. Calculate the total dollar amount of capital employed for Furman Inc.
3. Calculate economic value added (EVA) for Furman Inc. for last year. Is Furman Inc. creating or destroying wealth?
4. ***What if*** Furman Inc. had $15 million in common stock and no mortgage bonds or unsecured bonds? How would that affect the weighted average cost of capital? How would it affect EVA?

Solution:

1. $$\text{After-tax cost of mortgage bonds} = \text{Interest rate} - (\text{Tax rate} \times \text{Interest rate})$$
$$= [0.08 - (0.4 \times 0.08)] = 0.048$$
$$\text{After-tax cost of unsecured bonds} = \text{Interest rate} - (\text{Tax rate} \times \text{Interest rate})$$
$$= [0.10 - (0.4 \times 0.10)] = 0.06$$
$$\text{Cost of common stock} = \text{Return on long-term treasury bonds} + \text{Average premium}$$
$$= 0.06 + 0.06 = 0.12$$

2.

	Amount	Percent	×	After-Tax Cost	=	Weighted Cost
Mortgage bonds	$ 2,000,000	0.1333		0.048		0.0064
Unsecured bonds	3,000,000	0.2000		0.060		0.0120
Common stock	10,000,000	0.6667		0.120		0.0800
Total	$15,000,000					0.0984

Weighted average percentage cost of capital = 0.0984, or 9.84%
Total dollar amount of capital employed = 0.0984 × $15,000,000
= $1,476,000

3.

After-tax operating income	$1,583,000
Less: Total dollar amount of capital employed	1,476,000
EVA	$ 107,000

CORNERSTONE 10-3 *(continued)*

Furman Inc. is creating capital because EVA is positive (the after-tax earnings are greater than the after-tax cost of capital).

4. If all $15 million of financing were in common stock, the weighted average percentage cost of capital would be 12 percent and the total dollar amount of capital employed would be $1,800,000 (0.12 × $15,000,000). EVA would be negative, and Furman Inc. would be destroying wealth, not creating it.

$$\text{EVA} = \$1{,}583{,}000 - \$1{,}800{,}000 = \$(217{,}000)$$

consider inventories and warehouses to be "free" goods. Instead, the manager will strive to reduce capital usage and increase EVA. A reduction of capital usage to $8 million, for example, would boost EVA to $120,000 [$1,000,000 − (0.11 × $8,000,000)].

Quaker Oats faced a similar situation. Prior to 1991, Quaker Oats evaluated its business segments on the basis of quarterly profits. To keep quarterly earnings on an upward march, segment managers sharply discounted products at the end of each quarter. This resulted in huge orders from retailers and surges in production at Quaker's plants at the end of each three-month period. This practice is called trade loading because it "loads up the trade" (retail stores) with product. However, trade loading is expensive because it requires massive amounts of capital (e.g., working capital, inventories, and warehouses to store the quarterly spikes in output). Before EVA, a Quaker plant could run well below capacity early in the quarter. Purchasing, however, would buy huge quantities of boxes, plastic wrappers, granola, and chocolate chips, in anticipation of the production surge of the last six weeks of the quarter. As the products were finished, Quaker packed warehouses with finished goods. All costs associated with inventories were absorbed by corporate headquarters. Thus, they appeared to be free to the plant managers, who were encouraged to build ever higher inventories. The advent of EVA and the cancellation of trade loading led to a smoothing of production throughout the quarter, higher overall production (and sales), and lower inventories.

EVA can be used in the public sector, as well.

Multiple Measures of Performance

ROI, residual income, and EVA are important measures of managerial performance. However, they are financial measures, and may tempt managers to focus only on dollar figures. This focus may not tell the whole story for the company. In addition, lower-level managers and employees may feel helpless to affect net income or investment. To counter this, nonfinancial operating measures have been developed. For example, top management could look at such factors as market share, customer complaints, personnel turnover ratios, and personnel development. By letting lower-level managers know that attention to long-run factors is also vital, the tendency to overemphasize financial measures is reduced.

Modern managers are especially likely to use multiple measures of performance and to include nonfinancial as well as financial measures.

The Balanced Scorecard (discussed in Chapter 15) was developed to measure a firm's performance in multiple areas.

Measuring and Rewarding the Performance of Managers

OBJECTIVE 4
Discuss methods of evaluating and rewarding managerial performance.

While some companies consider the performance of the division to be equivalent to the performance of the manager, there is a compelling reason to separate the two. Often, the performance of the division is subject to factors beyond the manager's control. It is particularly important, then, to take a responsibility accounting approach and evaluate managers on the basis of factors under their control. A serious concern is the creation of a compensation plan that is closely tied to the performance of the division.

Incentive Pay for Managers—Encouraging Goal Congruence

Managerial evaluation and incentive pay would be of little concern if all managers were equally likely to perform up to the best of their abilities, and if those abilities were known in advance. In the case of a small company, owned and managed by the same person, there is no problem. The owner puts in as much effort as she or he wishes and receives all of the income as a reward for performance. However, in most companies, the owner hires managers to operate the company on a day-to-day basis and delegates decision-making authority to them. The shareholders of a company hire the CEO through the board of directors, and division managers are hired by the CEO to operate their divisions on behalf of the owners. Then, the owners must ensure that the managers are providing good service.

Why wouldn't managers provide good service? There are three reasons: (1) they may be unable to perform the job, (2) they may prefer not to work hard, and (3) they may prefer to spend company resources on perquisites. The first reason requires owners to discover information about the manager before hiring him. Think back to the reasons for decentralization—one was that it provided training for future managers. The training process provides signals about the managerial ability of division managers. The second and third reasons require the owner to monitor the manager or to arrange an incentive scheme that will more closely ally the manager's goals with those of the owner. Some managers may not want to do hard or routine work. Some may be risk-averse and not take actions that expose them, and the company, to risky situations. Thus, it is necessary to compensate them for undertaking risk and hard work. Closely related to the desire of some managers to shirk responsibility is the tendency of managers to overuse perquisites. **Perquisites** are a type of fringe benefit received over and above salary. Some examples are a nice office, use of a company car or jet, expense accounts, and company-paid country club memberships. While some perquisites are legitimate uses of company resources, they can be abused. A well-structured incentive pay plan can help to encourage goal congruence between managers and owners.

Managerial Rewards

Managerial rewards frequently include incentives tied to performance. The objective is to encourage goal congruence so that managers will act in the best interests of the firm. Managerial rewards may include the following:

1. Cash Compensation Cash compensation includes salaries and bonuses. Raises are one way for a company to reward good managerial performance. However, once the raise takes effect, it is usually permanent. Bonuses give a company more flexibility. Many companies use a combination of salary and bonus to reward performance by keeping salaries fairly level and allowing bonuses to fluctuate with reported income.

Managers may find their bonuses tied to divisional net income or to targeted increases in net income. For example, a division manager may receive an annual salary of $75,000 and a yearly bonus of 5 percent of the increase in reported net income. If net income does not rise, the manager's bonus is zero. This incentive pay scheme makes increasing net income, an objective of the owner, important to the manager as well.

Profit-sharing plans make employees partial owners in the sense that they receive a share of the profits. They are not owners in the sense of decision making or downside risk sharing. This is a form of risk sharing, in particular, sharing of upside risk. Typically, employees are paid a flat rate, and then, any profits to be shared are over and above wages. The objective is to provide an incentive for employees to work harder and smarter.

Income-based compensation can encourage dysfunctional behaviour. The manager may engage in unethical practices, such as postponing needed maintenance. If the bonus is capped at a certain amount (say the bonus is equal to 1 percent of net income but cannot exceed $50,000), managers may postpone revenue recognition from the end of the year in which the maximum bonus has already been achieved to the next year. Those who structure the reward systems need to understand both the positive incentives built into the system as well as the potential for negative behaviour.

2. Stock Options (Noncash Compensation) Stock is a share in the company, and theoretically, it should increase in value as the company does well and decrease in value as the company does poorly. Thus, the issuance of stock to managers makes them part owners of the company and should encourage goal congruence. Many companies encourage employees to purchase shares of stock, or they grant shares as a bonus. A disadvantage of stock as compensation is that share price can fall for reasons beyond the control of managers.

Companies frequently offer stock options to managers. A **stock option** is the right to buy a certain number of shares of the company's stock, at a particular price and after a set length of time. The objective of awarding stock options is to encourage managers to focus on the longer term. The price of the option shares is usually set at market price at the time of issue. Then, if the stock price rises in the future, the manager may exercise the option, thus purchasing stock at a below-market price and realizing an immediate gain.

Assume than an executive was granted an option to purchase 100,000 shares of company stock at the current market price of $20 per share. The option was granted in August 2011 and could be exercised after two years. If, by August 2013, the stock has risen to $23 per share, the executive can purchase all 100,000 shares for $2,000,000 (100,000 × $20 option price) and immediately sell them for $2,300,000 (100,000 × $23) for a profit of $300,000. Of course, if the stock price drops below $20, the executive will not exercise the option. Typically, however, stock prices rise along with the market, and the executive can safely bet on a future profit.

Companies are becoming more aware of the impact on options of the overall movement of the stock market. If the market moves strongly higher, there is the potential for windfall profits. That is, any profit realized from selling stock based on low cost options may be more closely related to the overall rise in the stock market and less related to outstanding performance by top management. In addition, top executives with a number of options may focus on the short-term movements of the stock price rather than on the long-term indicators of company performance. In essence, they may trade long-term returns for short-term returns.

Typically, there are constraints on the exercise of the options. For example, the stock purchased with options may not be sold for a certain period of time. A disadvantage of stock options is that the price of the stock is based on many factors and is not completely within the manager's control.

Issues to Consider in Structuring Cash-Based Compensation Single measures of performance, which are often the basis of bonuses, are subject to gaming behaviour in that managers may increase short-term measures at the expense of long-term measures. For example, a manager may keep net income high by refusing to

invest in more modern and efficient equipment. Depreciation expense remains low, but so do productivity and quality. Clearly, the manager has an incentive to understand the computation of the accounting numbers used in performance evaluation. An accounting change in inventory valuation or in the method of depreciation, for example, will change net income even though sales and costs remain unchanged. Frequently, we see that a new CEO of a troubled corporation will take a number of losses (e.g., inventory write-downs) all at once. This is referred to as the "big bath" and usually results in very low (or negative) net income in that year. Then, the books are cleared for a good increase in net income, and a correspondingly large bonus, for the next year.

Both cash bonuses and stock options can encourage a short-term orientation. To encourage a longer-term orientation, some companies require top executives to purchase and hold a certain amount of company stock to retain employment.

Another issue to be considered in structuring management compensation plans is that owners and managers may be affected differently by risk. When managers have so much of their own capital—both financial and human—invested in the company, they may be less apt to take risks. Owners, because of their ability to diversify away some of the risk, may prefer a more risk-taking attitude. As a result, managers must be somewhat insulated from catastrophic downside risk in order to encourage them to make entrepreneurial decisions.

Noncash Compensation We often see managers who trade off increased salary for improvements in title, office location and trappings, use of expense accounts, and so on. Perquisites can be well used to make the manager more efficient. For example, a busy manager may be able to effectively employ several assistants and may find that use of a corporate jet allows him or her to more efficiently schedule travel in overseeing far-flung divisions. However, perquisites may be abused as well. One wonders how the shareholders of a corporation can benefit from extravagant parties organized by the CEO in exotic, expensive locations. These parties are intended to promote the corporation's image. They sometimes also satisfy the vanity and ego of some executives.

Measuring Performance in the Multinational Firm

It is important for the MNC to separate the evaluation of the *manager* of a division from the evaluation of the *division*. The manager's evaluation should not include factors over which he exercises no control, such as currency fluctuations, income taxes, and so on. It is particularly difficult to compare the performance of a manager of a division (or subsidiary) in one country with the performance of a manager of a division in another country. Even divisions that appear to be similar in terms of production may face very different economic, social, or political forces. Instead, managers should be evaluated on the basis of revenues and costs incurred. Once a manager is evaluated, then the subsidiary financial statements can be restated to the home currency and uncontrollable costs can be allocated.[7]

International environmental conditions may be very different from, and more complex than, domestic conditions. Environmental variables facing local managers of divisions include economic, legal, political, social, and educational factors. Some important economic variables are inflation, foreign currency exchange rates, income taxes, and transfer prices.

Legal and political factors are important. For example, a country may not allow cash outflows or may forbid the import of certain items, such as guns.

Educational, infrastructure, and cultural variables affect how the multinational firm is treated by the subsidiary's country. Many clothing distributors depend on factories in developing countries to do the manufacturing. However, first, those companies had to develop the area, putting in roads and communication equipment and providing training for workers.

[7] Helen Gernon and Gary Meek, *Accounting: An International Perspective* (Homewood, IL: Richard D. Irwin-McGraw-Hill, 2001).

Comparison of Divisional ROI The existence of differing environmental factors makes interdivisional comparison of ROI potentially misleading. For example, the lack of consistency in internal reporting may obscure interdivisional comparison. A minimum wage law in one country may restrict the manager's ability to affect labour costs. Another country may prevent the export of cash. Still others may have a well-educated workforce but poor infrastructure (transportation and communication facilities). Therefore, the corporation must be aware of and control these differing environmental factors when assessing managerial performance.

The modern accountant who works in a global environment must be aware of more than business and finance. Political and legal systems have important implications for the company. Sometimes, the political system changes quickly, throwing the company into crisis mode. Other times, the situation evolves more slowly.

On occasion, the political structure may mean that North American standards of control may not "work" in foreign countries. The business objective for a socialist country may not be efficiency or effectiveness, but compliance with the central plan. This culture of altering the plan to match the actual results continues to exist in some countries.

Multiple Measures of Performance Rigid evaluation of the performance of foreign divisions of the MNC ignores the overarching strategic importance of developing a global presence. The interconnectedness of the global company weakens the independence or stand-alone nature of any one segment. As a result, residual income and ROI are less important measures of managerial performance for divisions of the MNC. MNCs must use additional measures of performance that relate more closely to the long-run health of the company. In addition to ROI and residual income, top management looks at such factors as market potential and market share.

Additionally, the use of ROI and RI in the evaluation of managerial performance in divisions of an MNC is subject to problems beyond those faced by a decentralized company that operates in only one country. It is particularly important, then, to take a responsibility accounting approach and evaluate managers on the basis of factors under their control. Multiple measures of performance, keyed to local operating conditions, can spotlight managers' responses to different and difficult operating conditions.

OBJECTIVE 5
Explain the role of transfer pricing in a decentralized firm.

Transfer Pricing

Often, the output of one division can be used as input for another division. For example, integrated circuits produced by one division can be used by a second division to make video recorders. **Transfer prices** are the prices charged for goods produced by one division and transferred to another. The price charged affects the revenues of the transferring division and the costs of the receiving division. As a result, the profitability, return on investment, and managerial performance evaluation of both divisions are affected.

The Impact of Transfer Pricing on Income

Exhibit 10-1 illustrates the effect of the transfer price on two divisions of ABC Inc. Division A produces a component and sells it to another division of the same company, Division C. The $30 transfer price is revenue to Division A and increases division income; clearly, Division A wants the price to be as high as possible. Conversely, the $30 transfer price is cost to Division C and decreases division income, just like the cost of any materials. Division C prefers a lower transfer price. For the company as a whole, A's revenue minus C's cost equals zero.

While the actual transfer price nets out for the company as a whole, transfer pricing can affect the level of profits earned by the company as a whole if it affects divisional behaviour. Divisions, acting independently, may set transfer prices that maximize divisional profits but adversely affect firmwide profits. For example, suppose that Division A in Exhibit 10-1 sets a transfer price of $30 for a component that

Exhibit 10-1

Impact of Transfer Price on Transferring Divisions and the Company as a Whole

ABC Inc.	
Division A	**Division C**
Produces component and transfers it to C for transfer price of $30 per unit	Purchases component from A at transfer price of $30 per unit and uses it in production of final product
Transfer price = $30 per unit	Transfer price = $30 per unit
Revenue to A	Cost to C
Increases net income	Decreases net income
Increases ROI	Decreases ROI
Transfer price revenue = Transfer price cost Zero impact on ABC Inc.	

costs $24 to produce. If Division C can obtain the component from an outside supplier for $28, it will refuse to buy from Division A. Division C will realize a savings of $2 per component ($30 internal transfer price − $28 external price). However, if Division A cannot replace the internal sales with external sales, the company as a whole will be worse off by $4 per component ($28 external cost − $24 internal cost). This outcome would increase the total cost to the firm as a whole. Thus, how transfer prices are set can be critical for profits of the business as a whole.

Setting Transfer Prices

OBJECTIVE 6
Discuss the methods of setting transfer prices.

A transfer pricing system should satisfy three objectives: accurate performance evaluation, goal congruence, and preservation of divisional autonomy.[8] Accurate performance evaluation means that no one divisional manager should benefit at the expense of another (in the sense that one division is made better off while the other is made worse off). Goal congruence means that divisional managers select actions that maximize firmwide profits. Autonomy means that central management should not interfere with the decision-making freedom of divisional managers. The **transfer pricing problem** concerns finding a system that simultaneously satisfies all three objectives.

We can evaluate the degree to which a transfer price satisfies the objectives of a transfer pricing system by considering the opportunity cost of the goods transferred. The *opportunity cost approach* can be used to describe a wide variety of transfer pricing practices. Under certain conditions, this approach is compatible with the objectives of performance evaluation, goal congruence, and autonomy.

The **opportunity cost approach** identifies the minimum price that a selling division would be willing to accept and the maximum price that the buying division would be willing to pay. These minimum and maximum prices correspond to the opportunity costs of transferring internally and they define a *bargaining range*. They are defined for each division as follows:

1. The **minimum transfer price**, or floor, is the transfer price that would leave the selling division no worse off if the good is sold to an internal division. Note that the selling division would prefer a higher price; however, the minimum transfer price is the absolute lowest that could be accepted.
2. The **maximum transfer price**, or ceiling, is the transfer price that would leave the buying division no worse off if an input is purchased from an internal

[8] Joshua Ronen and George McKinney, "Transfer Pricing for Divisional Autonomy," *Journal of Accounting Research* (Spring 1970): 100–101.

division. Note that the buying division would prefer a lower price; however, the maximum transfer price is the absolute highest that could be accepted.

The opportunity cost approach tells us that a good should be transferred internally whenever the opportunity cost (minimum price) of the selling division is less than the opportunity cost (maximum price) of the buying division. By definition, this approach ensures that neither divisional manager is made worse off by transferring internally. This means that total divisional profits are not decreased by the internal transfer.

Central management rarely sets specific transfer prices. Instead, most companies develop some general policies that divisions must follow. Three commonly used policies are market-based transfer pricing, negotiated transfer pricing, and cost-based transfer pricing. Each of these can be evaluated according to the opportunity cost approach.

Market Price

If there is an outside market for the good to be transferred and that outside market is perfectly competitive, the correct transfer price is the market price.[9] In such a case, divisional managers' actions will simultaneously optimize divisional profits and firm-wide profits. No division can benefit at the expense of another division and central management will not be tempted to intervene.

The opportunity cost approach also signals that the correct transfer price is the market price. Since the selling division can sell all that it produces at the market price, transferring internally at a lower price would make that division worse off. Similarly, the buying division can always acquire the intermediate good at the market price, so it would be unwilling to pay more for an internally transferred good. Since the minimum transfer price for the selling division is the market price and since the maximum price for the buying division is also the market price, the only possible transfer price is the market price.

In fact, moving away from the market price will decrease the overall profitability of the firm. This principle can be used to resolve divisional conflicts that may occur, as the following example illustrates.

Yarrow Company is a decentralized manufacturer of small appliances. The Parts Division, which is at capacity, produces parts that are used by the Motor Division. The parts can also be sold to other manufacturers and to wholesalers at a market price of $8. For all practical purposes, the market for the parts is perfectly competitive.

Suppose that the Motor Division, operating at 70 percent capacity, receives a special order for 100,000 motors at a price of $30. Full manufacturing cost of the motors is $31, broken down as follows:

Direct materials	$10
Transferred-in part	8
Direct labour	2
Variable overhead	1
Fixed overhead	10
Total cost	$31

Notice that the motor includes a part transferred in from the Parts Division at a market-based transfer price of $8. Should the Parts Division lower the transfer price to allow the Motor Division to accept the special order? The opportunity cost approach helps us to answer this question.

Since the Parts Division can sell all that it produces, the minimum transfer price is the market price of $8. Any lower price would make the Parts Division worse off.

[9] A perfectly competitive market for the intermediate product requires four conditions: (1) the division producing the intermediate product is small relative to the market as a whole and cannot influence the price of the product; (2) the intermediate product is indistinguishable from the same product of other sellers; (3) firms can easily enter and exit the market; and (4) consumers, producers, and resource owners have perfect knowledge of the market.

For the Motor Division, identifying the maximum transfer price that can be paid so that it is no worse off is a bit more complex.

Since the Motor Division is under capacity, the fixed overhead portion of the motor's cost is not relevant. The relevant costs are those additional costs that will be incurred if the order is accepted. These costs, excluding for the moment the cost of the transferred-in component, equal $13 ($10 + $2 + $1). Thus, the contribution to profits before considering the cost of the transferred-in component is $17 ($30 − $13). The division could pay as much as $17 for the component and still break even on the special order. However, since the component can always be purchased from an outside supplier for $8, the maximum price that the division should pay internally is $8. Thus, the market price is the best transfer price.

Negotiated Transfer Prices

Perfectly competitive markets rarely exist. In most cases, producers *can* influence price (e.g., by being large enough to influence demand by dropping the price of the product or by selling closely related but differentiated products). When imperfections exist in the market for the intermediate product, market price may no longer be suitable. In this case, negotiated transfer prices may be a practical alternative. Opportunity costs help define the boundaries of the negotiation set.

Example 1: Avoidable Distribution Costs Assume that a division produces a circuit board. Currently, the division sells 1,000 units per day, with variable manufacturing costs of $12 per unit. The division can sell all that it produces to the outside market at $22. Any outside sales incur a distribution cost of $2 per unit. Alternatively, the board can be sold internally to the company's recently acquired Electronic Games Division. There is no distribution cost if the board is sold internally.

The Electronic Games Division, also at capacity, produces and sells 350 games per day. These games sell for $45 per unit and have variable manufacturing costs of $32 per unit. Variable selling expenses of $3 per unit are also incurred. Sales and production data for each division are summarized in Exhibit 10-2.

How could the Games Division and the Circuit Board Division set a transfer price? If the Games Division currently pays $22 per circuit board, it would refuse to pay more than $22; thus, the maximum transfer price is $22. The minimum transfer price is set by the Circuit Board Division. While this division prices its circuit boards at $22, it will avoid $2 of distribution cost if it sells internally. Therefore, the minimum transfer price is $20 ($22 − $2). The bargaining range for the transfer price is between $20 and $22.

Suppose that the Games Division manager offered a transfer price of $20. That division would be better off by $2 per circuit board, since it had previously paid $22

Exhibit 10-2

Summary of Sales and Production Data

	Circuit Board Division	Games Division
Units sold:		
Per day	1,000	350
Per year*	260,000	91,000
Unit data:		
Selling price	$22	$45
Variable costs:		
Manufacturing	$12	$32
Selling	$2	$3
Annual fixed costs	$1,480,000	$610,000

*There are 260 selling days in a year.

Exhibit 10-3

Comparative Income Statements

Before Negotiation: All Sales External			
	Circuit Board Division	**Games Division**	**Total**
Sales	$ 5,720,000	$ 4,095,000	$ 9,815,000
Less variable expenses:			
Cost of goods sold	(3,120,000)	(2,912,000)	(6,032,000)
Variable selling	(520,000)	(273,000)	(793,000)
Contribution margin	2,080,000	910,000	2,990,000
Less: Fixed expenses	1,480,000	610,000	2,090,000
Operating income	$ 600,000	$ 300,000	$ 900,000
After Negotiation: Internal Transfers @ $21.10			
	Circuit Board Division	**Games Division**	**Total**
Sales	$ 5,638,100	$ 4,095,000	$ 9,733,100
Less variable expenses:			
Cost of goods sold	(3,120,000)	(2,830,100)	(5,950,100)
Variable selling	(338,000)	(273,000)	(611,000)
Contribution margin	2,180,100	991,900	3,172,000
Less: Fixed expenses	1,480,000	610,000	2,090,000
Operating income	$ 700,100	$ 381,900	$ 1,082,000
Change in operating income	$ 100,100	$ 81,900	$ 182,000

per board. Its profits would increase by $700 per day ($2 × 350 units per day). The Circuit Board Division, on the other hand, would be no better, or worse, off than before and would earn no additional profit. While a transfer price of $20 per circuit board is possible, it is unlikely that the Circuit Board manager would agree to it.

Now suppose that the Circuit Board Division counters with an offer of $21.10 per board. That transfer price allows the Circuit Board Division to increase its profits by $385 per day [($21.10 − $20) × 350 units]. The Games Division would increase its profits by $315 per day [($22 − $21.10) × 350 units].

While we cannot tell exactly where the Circuit Board Division and the Games Division would set a transfer price, we can see that it will be somewhere within the bargaining range. [The minimum transfer price ($20) and the maximum transfer price ($22) set the limits of the bargaining range.] Exhibit 10-3 provides income statements for each division before and after the agreement. Notice how the profit increase is split between the two divisions.

Example 2: Excess Capacity In perfectly competitive markets, the selling division can sell all that it wishes at the prevailing market price and would produce at capacity. In a less ideal setting, a selling division may be unable to sell all that it produces; accordingly, the division may have excess capacity.[10]

To illustrate the role of transfer pricing and negotiation in this setting, consider the dialogue between Sharena Casper, manager of a Plastics Division, and Manny Rogers, manager of a Pharmaceutical Division:

MANNY: Sharena, my division has shown a loss for the past three years. When I took over the division at the beginning of the year, I set a goal with headquarters to break

[10] Output can be increased by decreasing selling price. Of course, decreasing selling price to increase sales volume may not increase profits—in fact, profits could easily decline. We assume in this example that the divisional manager has chosen the most advantageous selling price and that the division is still left with excess capacity.

even. At this point, projections show a loss of $5,000—but I think I have a way to reach my goal, if I can get your cooperation.

SHARENA: If I can help, I will. What do you have in mind?

MANNY: I need a special deal on your plastic bottle Model 3. A large West Coast retail chain wants to buy 250,000 bottles. But we have to give them a real break on price. They have offered $0.85 per unit. My variable cost per unit is $0.60, not including the cost of the plastic bottle. I normally pay $0.40 for your bottle, but if I do that, the order will lose me $37,500. I can't afford that kind of loss. I know that you have excess capacity. If you can make 250,000 bottles, I'll pay your variable cost per unit, provided it is no more than $0.25. Are you interested? Can you handle that size order?

SHARENA: I have enough excess capacity to handle the order easily and my variable cost is $0.15. However, I want part of the profit. I'll let you have the order for $0.20. That way, we both make $0.05 per bottle, for a total contribution of $12,500. That'll put you in the black and help me get closer to my budgeted profit goal.

MANNY: Great! Thanks so much. If this West Coast chain provides more orders in the future—as I expect it will—and at better prices, I'll make sure you get our business.

Notice the role that opportunity costs play in the negotiation. In this case, the minimum transfer price is the Plastic Division's variable cost ($0.15), representing the incremental outlay if the order is accepted. Since the division has excess capacity, only variable costs are relevant to the decision. By covering the variable costs, the order does not affect the division's total profits. For the buying division, the maximum transfer price is the purchase price that would allow the division to cover its incremental costs on the special order ($0.25). Adding the $0.25 to the other costs of processing ($0.60), the total incremental costs incurred are $0.85 per unit. Since the selling price is also $0.85 per unit, the division is made no worse off. Both divisions, however, can be better off if the transfer price is between the minimum price of $0.15 and the maximum price of $0.25.

Comparative statements showing the contribution margin earned by each division and the firm as a whole are shown in Exhibit 10-4 for each of the four transfer prices discussed. These statements show that the firm earns the same profit for all four transfer prices; however, different prices do affect the individual divisions' profits differently. Because of the autonomy of each division, there is no guarantee that the firm will earn the maximum profit. For example, if Sharena had insisted on maintaining the price of $0.40, no transfer would have taken place, and the overall $25,000 increase in profits would have been lost.

Disadvantages of Negotiated Transfer Prices Negotiated transfer prices have three disadvantages that are commonly mentioned.

1. One divisional manager with private information may take advantage of another divisional manager.
2. Performance measures may be distorted by the negotiating skills of managers.
3. Negotiation can consume considerable time and resources.

ETHICS It is interesting that Manny, the manager of the Pharmaceutical Division, did not know the variable cost of producing the plastic bottle. Yet that cost was a key to the negotiation. Clearly, he had not done his homework before starting the negotiation. This lack of knowledge gave Sharena, the other divisional manager, the opportunity to exploit the situation. For example, she could have claimed that the variable cost was $0.27 and offered to sell for $0.25 per unit as a favour to Manny, saying that she would absorb a $5,000 loss in exchange for a promise of future business. In this case, she would capture the full $25,000 benefit of the transfer. Alternatively, she could have misrepresented the figure and used it to turn down the request, thus preventing Manny from achieving his budgetary goal; after all, she may be competing with Manny for promotions, bonuses, salary increases, and so on.

Exhibit 10-4

Comparative Statements

	Pharmaceutical	Plastics	Total
Transfer Price of $0.40			
Sales	$212,500	$100,000	$312,500
Less: Variable expenses	250,000	37,500	287,500
Contribution margin	$ (37,500)	$ 62,500	$ 25,000
Transfer Price of $0.25			
Sales	$212,500	$62,500	$275,000
Less: Variable expenses	212,500	37,500	250,000
Contribution margin	$ 0	$25,000	$ 25,000
Transfer Price of $0.20			
Sales	$212,500	$50,000	$262,500
Less: Variable expenses	200,000	37,500	237,500
Contribution margin	$ 12,500	$12,500	$ 25,000
Transfer Price of $0.15			
Sales	$212,500	$37,500	$250,000
Less: Variable expenses	187,500	37,500	225,000
Contribution margin	$ 25,000	$ 0	$ 25,000

Fortunately, Sharena displayed sound judgment and acted with integrity.[11] For negotiation to work, managers must be willing to share relevant information. How can this requirement be satisfied? Perhaps the best course of action is to hire managers with integrity—managers who have a commitment to ethical behaviour. Additionally, top management can take other actions to discourage the use of private information for exploitive purposes. For example, corporate headquarters could base some part of the management reward structure on overall profitability to encourage actions that are in the best interests of the company as a whole.◆

The second disadvantage of negotiated transfer prices is that the practice distorts the measurement of managerial performance. According to this view, divisional profitability may be affected too strongly by the negotiating skills of managers, masking the actual management of resources entrusted to each manager. Although this argument may have some merit, it ignores the fact that negotiating is a desirable skill. Perhaps divisional profitability should reflect differences in negotiating skills.

The third criticism of this technique is that negotiating is time consuming. The time spent in negotiation could be spent managing other activities necessary to the success of the division. Sometimes, negotiations reach an impasse, forcing top management to spend time mediating the process.[12] Although negotiating takes time, a mutually satisfactory outcome can increase profits for the divisions and the firm. Furthermore, negotiation does not have to be repeated each time for similar transactions.

Advantages of Negotiated Transfer Prices Although time consuming, negotiated transfer prices offer some hope of complying with the three criteria of goal

[11] Because of the excess capacity, her agreement to work with Manny was beneficial for both of their divisions. Note that if she had not had excess capacity, it would have been better for her division and for the company as a whole to refuse the special offer to Manny's division and to sell for full price to outsiders.

[12] The involvement of top management may be very cursory, however. In the case of a very large oil company that negotiates virtually all transfer prices, two divisional managers could not come to an agreement after several weeks of effort and appealed to their superior. His response: "Either come to an agreement within 24 hours, or you are both fired." Needless to say, an agreement was reached within the allotted time.

congruence, autonomy, and accurate performance evaluation. Just as important, however, is the process of making sure that actions of the different divisions mesh together so that the company's overall goals are attained. If negotiation helps ensure goal congruence, there is no need for central management to intervene. Finally, if negotiating skills of divisional managers are comparable or if the firm views these skills as an important managerial skill, concerns about motivation and accurate performance measures are avoided. Cornerstone 10-4 shows the how and why of calculating market-based and negotiated transfer prices.

Cost-Based Transfer Prices

Three forms of cost-based transfer pricing will be considered: full cost, full cost plus markup, and variable cost plus fixed fee. In all cases, standard costs should be used to avoid passing on the inefficiencies of one division to another. A more important issue, however, is the propriety of cost-based transfer prices. Under what circumstances, if any, should they be used?

Full-Cost Transfer Pricing Perhaps the least desirable type of transfer pricing approach is full cost. Its only real virtue is simplicity. Full-cost transfer pricing can provide perverse incentives and distort performance measures. As we have seen, the opportunity costs of both the buying and selling divisions are essential for determining the propriety of internal transfers. At the same time, they provide useful reference points for determining a mutually satisfactory transfer price. Only rarely will full cost provide accurate information about opportunity costs.

A full-cost transfer price would have shut down the negotiations described earlier. In the first example, the manager would never have considered transferring internally if the price had to be full cost. Yet by transferring at selling price less some distribution expenses, both divisions—and the firm as a whole—were better off. In the second example, the manager of the Pharmaceutical Division could never have accepted the special order with the West Coast chain. Both divisions and the company would have been worse off.

Full Cost Plus Markup Full cost plus markup suffers from virtually the same problems as full cost. It is somewhat less perverse, however, if the markup can be negotiated. For example, a full-cost-plus-markup formula could have been used to represent the negotiated transfer price of the first example. In some cases, a full-cost-plus-markup formula may be the outcome of negotiation; if so, it is simply another example of negotiated transfer pricing. In these cases, the use of this method is fully justified. Using full cost plus markup to represent all negotiated prices, however, is not possible (e.g., it could not be used to represent the negotiated price of the second example). The superior approach is negotiation, since more cases can be represented, and full consideration of opportunity costs is possible.

Variable Cost Plus Fixed Fee Like full cost plus markup, variable cost plus fixed fee can be a useful transfer pricing approach provided that the fixed fee is negotiable. This method has one advantage over full cost plus markup: if the selling division is operating below capacity, variable cost is its opportunity cost. Assuming that the fixed fee is negotiable, the variable cost approach can be equivalent to negotiated transfer pricing. Negotiation with full consideration of opportunity costs is preferred.

Propriety of Use Despite the disadvantages of cost-based transfer prices, many companies use these methods, especially full cost and full cost plus markup. These methods are simple and objective. In addition, often transfers between divisions have a small impact on the profitability of either division. Thus, it may be cost effective to use an easy-to-identify, cost-based formula rather than spending valuable time and resources on negotiation.

CORNERSTONE 10-4

The HOW and WHY of Calculating Market-Based and Negotiated Transfer Prices

Information:

Omni Inc. has a number of divisions, including Alpha Division, producer of circuit boards, and Delta Division, a heating and air conditioning manufacturer.

Alpha Division produces the cb-117 model that can be used by Delta Division in the production of thermostats that regulate the heating and air conditioning systems. The market price of the cb-117 is $14. Cost information for the cb-117 model is:

Variable product cost	$2.50
Fixed cost	6.50
Total product cost	$9.00

Delta needs 30,000 units of model cb-117 per year. Alpha Division is at full capacity (100,000 units of cb-117).

Required:

1. If Omni Inc. has a transfer pricing policy that requires transfer at market price, what would the transfer price be? Do you suppose that Alpha and Delta divisions would choose to transfer at that price?
2. Now suppose that Omni Inc. allows negotiated transfer pricing and that Alpha Division can avoid $3 of selling and distribution expense by selling to Delta Division. Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Alpha and Delta divisions would choose to transfer somewhere in the bargaining range?
3. ***What if*** Alpha Division plans to produce and sell only 65,000 units of cb-117 next year (excess capacity exists)? Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Alpha and Delta divisions would choose to transfer somewhere in the bargaining range?

Solution:

1. The market price is $14. Both Delta and Alpha divisions would be willing to transfer at that price (since neither division would be worse off than if it bought/sold in the outside market).
2. Minimum transfer price = $14 − $3 = $11. It is set by Alpha, the selling division. Maximum transfer price = $14. It is the market price and is set by Delta, the buying division.

   Yes, both divisions would be willing to accept a transfer price within the bargaining range. The actual transfer price set depends on the negotiating skills of the Alpha and Delta division managers.
3. Minimum transfer price = $2.50 (the variable cost of production). This price is set by Alpha, the selling division. Maximum transfer price = $14. This is the market price and is set by Delta, the buying division.

   Both divisions would be willing to accept a transfer price within the bargaining range. The actual transfer price depends on the negotiating skills of the Alpha and Delta division managers. (Notice that the fixed product costs are not included in the minimum transfer price because Alpha will have to pay total fixed cost no matter how many units are produced.)

In other cases, the use of full cost plus markup may simply be the formula agreed upon in negotiations. That is, the full-cost-plus-markup formula is the outcome of negotiation, but the transfer pricing method being used is reported as full cost plus markup. Once established, this formula could be used until the original conditions change to the point where renegotiation is necessary. In this way, the time and resources of negotiation can be minimized. For example, the goods transferred may be custom-made, and the managers may have little ability to identify an outside market price. In this case, reimbursement of full costs plus a reasonable rate of return may be a good surrogate for the transferring division's opportunity costs. Cornerstone 10-5 shows how and why cost-based transfer prices are calculated.

Transfer Pricing and the Multinational Firm

For the multinational firm, transfer pricing must accomplish two objectives: performance evaluation and optimal determination of income taxes. If all countries had the same tax structure, then transfer prices would be set independently of income taxes. However, there are high-tax countries (like Canada) and low-tax countries (such as the Cayman Islands). As a result, MNCs may use transfer pricing to shift costs to high-tax countries and shift revenues to low-tax countries.

Exhibit 10-5 illustrates this concept, as two transfer prices are set. The first transfer price is $100 as title for the goods passes from the Belgian subsidiary to the reinvoicing centre in Puerto Rico. Because the first transfer price is equal to full cost, profit is zero, and income taxes on zero profit also equal zero. The second transfer price is set at $200 by the reinvoicing centre in Puerto Rico. The transfer from Puerto Rico to Canada does result in profit, but this profit does not result in any income tax because Puerto Rico has no corporate income taxes. Finally, the Canadian subsidiary sells the product to an external party at the $200 transfer price. Again, price equals cost, so there is no profit on which to pay income taxes. Consider what would have happened without the reinvoicing centre. The goods would have gone directly from Belgium to Canada. If the transfer price was set at $200, the profit in Belgium would have been $100, subject to the 42 percent tax rate. Alternatively, if the transfer price set was $100, no Belgian income tax would have been paid, but the Canadian subsidiary would have realized a profit of $100, and that would have been subject to the Canadian corporate income tax rate of 35 percent.

Canadian-based multinationals are subject to CRA regulations on the pricing of intercompany transactions. CRA has the authority to reallocate income and deductions among divisions if it believes that such reallocation will reduce potential tax evasion. Transfer prices and sales among companies should be made at arm's length. That is, the transfer price set should match the price that would be set if the transfer were being made by unrelated parties, adjusted for differences that have a measurable effect on the price. Differences include landing costs and marketing costs. Landing costs (e.g., freight, insurance, customs duties, and special taxes) can increase the allowable transfer price. Marketing costs are usually avoided for internal transfers and reduce the transfer price. The CRA allows three pricing methods that approximate arm's-length pricing. In order of preference, these are the comparable uncontrolled price method, the resale price method, and the cost-plus method. The **comparable uncontrolled price method** is essentially market price. The **resale price method** is equal to the sales price received by the reseller less an appropriate markup. That is, the subsidiary purchasing a good for resale sets a transfer price equal to the resale price less a gross profit percentage. The **cost-plus method** is simply the cost-based transfer price. Cornerstone 10-6 shows the how and why of using the comparable uncontrolled price method and the resale price method.

The determination of an arm's-length price is a difficult one. Many times, the transfer pricing situation facing a company does not "fit" any of the three preferred methods just outlined. At such times, there may be room for a negotiated transfer price agreed upon between the CRA and the company. The CRA, taxpayers, and the Tax Court have struggled with negotiated transfer prices for years. However, this type

CORNERSTONE 10-5

The HOW and WHY of Calculating Cost-Based Transfer Prices

Information:

Omni Inc. has a number of divisions, including Alpha Division, producer of circuit boards, and Delta Division, a heating and air conditioning manufacturer.

Alpha Division produces the cb-117 model that can be used by Delta Division in the production of thermostats that regulate the heating and air conditioning systems. The market price of the cb-117 is $14. Cost information for the cb-117 model is:

Variable product cost	$2.50
Fixed cost	6.50
Total product cost	$9.00

Delta needs 30,000 units of model cb-117 per year. Alpha Division is at full capacity (100,000 units of cb-117).

Required:

1. If Omni Inc. has a transfer pricing policy that requires transfer at full product cost, what would the transfer price be? Do you suppose that Alpha and Delta divisions would choose to transfer at that price?
2. If Omni Inc. has a transfer pricing policy that requires transfer at full cost plus 25 percent, what would the transfer price be? Do you suppose that Alpha and Delta divisions would choose to transfer at that price?
3. If Omni Inc. has a transfer pricing policy that requires transfer at variable product cost plus a fixed fee of $12.00 per unit, what would the transfer price be? Do you suppose that Alpha and Delta divisions would choose to transfer at that price?
4. ***What if*** Alpha Division plans to produce and sell only 65,000 units of cb-117 next year? The Omni Inc. policy is that all transfers be at full cost. Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Alpha and Delta divisions would choose to transfer?

Solution:

1. The full cost transfer price is $9.00. Delta Division would be delighted with that price, but Alpha Division would refuse to transfer since $14 could be earned in the outside market.
2. The cost-plus transfer price is $11.25 ($9.00 + $2.25). Again, Delta Division would be delighted with that price, but Alpha Division would refuse to transfer since $14 could be earned in the outside market.
3. The variable product cost plus fixed fee is $14.50 ($2.50 + $12). In this case, Alpha would be delighted, but Delta would refuse, since it can buy all it needs on the outside market for $14.
4. Minimum transfer price = $9.00 (the full cost of production). This price is set by Alpha, the selling division. Maximum transfer price = $14. This is the market price and is set by Delta, the buying division.

   Yes, both divisions would be willing to accept the transfer price of $9.00 per unit.

Exhibit 10-5

Use of Transfer Pricing to Affect Income Taxes Paid

Action	Tax Impact
Belgian subsidiary of Parent Company produces a component at a cost of $100 per unit. Title to the component is transferred to a reinvoicing centre* in Puerto Rico at a transfer price of $100/unit.	42% tax rate $100 revenue − $100 cost = $0 Taxes paid = $0
Reinvoicing centre in Puerto Rico, also a subsidiary of Parent Company, transfers title of component to Canadian subsidiary of Parent Company at a transfer price of $200/unit.	0% tax rate $200 revenue − $100 cost = $100 Taxes paid = $0
Canadian subsidiary sells component to external company at $200 each.	35% tax rate $200 revenue − $200 cost = $0 Taxes paid = $0

*A reinvoicing centre takes title to the goods but does not physically receive them. The primary objective of a reinvoicing centre is to shift profits to divisions in low-tax countries.

of negotiation occurs after the fact—that is, after income tax returns have been submitted and the company is being audited. **The CRA may or may not accept a transfer price as a transfer of intangibles (such as royalties on licences), sales of property, provision of services, and other items**.

Transfer pricing abuses are illegal—if they can be proved to be abuses. For example in some celebrated cases, toothbrushes were priced at more than $5,600 each for import from the United Kingdom into the United States, car seats were exported to Belgium for $1.66 each, and missile and rocket launchers were exported to Israel for just $52 each.

Of course, MNCs are also subject to taxation by other countries as well as Canada. Since income taxes are virtually universal, consideration of income tax effects pervades management decision making. Canada, the United States, Japan, the European Union, and South Korea have all issued transfer pricing regulations within the past 20 years. This increased emphasis on transfer price justification may account for the increased use of market prices as the transfer price by MNCs. However, research has shown that even market-based transfer prices can vary significantly from market prices set for a virtually identical arm's-length transaction.[13] It is thought that a highly important environmental variable considered by MNCs in setting a transfer pricing policy is overall profit to the company—with overall profit including the income tax impact of intra-company transfers.

Managers may legally avoid income taxes; they may not evade them. The distinction is important. Unfortunately, the difference between avoidance and evasion is less a line than a blurry gray area. While the situation depicted in Exhibit 10-5 is clearly abusive, other tax-motivated actions are not. For example, an MNC may decide to establish a needed research and development centre within an existing subsidiary in a high-tax country, since the costs are deductible. MNCs may have income tax-planning information systems that attempt to accomplish global income tax minimization. This is not an easy task.

[13] Andrew B. Bernard, J. Bradford Jensen, and Peter K. Schotts, "Transfer Pricing by U.S.-Based Multinational Firms," (September 2008). Tuck School of Business Working Paper No. 2006-33; U.S. Census Bureau Centre for Economic Studies Paper No. CES-WP-08-29. Available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=924573.

CORNERSTONE 10-6

The HOW and WHY of Using the Comparable Uncontrolled Price Method and the Resale Price Method in Calculating Transfer Prices

Information:

ABC Inc. has a number of divisions around the world. Division B (in the United States) purchases a component from Division C (in Canada). The component can be purchased externally for $38 each. The freight and insurance on the item amount to $5; however, commissions of $3.80 need not be paid.

Required:

1. Calculate the transfer price using the comparable uncontrolled price method.
2. Suppose that there is no outside market for the component that Division C transfers to Division B. Further assume that Division B sells the component for $42 and normally receives a 40 percent markup on cost of goods sold. Calculate the transfer price using the resale price method.
3. Now assume that there is no external market for the component transferred from Division C to Division B, and that the component is used in the manufacture of another product (i.e., it is not resold). Calculate the transfer price using the cost-plus method. Further assume that Division C's manufacturing cost for the component is $20.
4. ***What if*** freight and insurance were $4 per unit? How would that affect the comparable uncontrolled price? The cost-plus price?

Solution:

1. The comparable uncontrolled price is calculated as follows:

Market price	$38.00
Plus: Freight and insurance	5.00
Less: Commissions	(3.80)
Transfer price	$39.20

2. With no outside market for Division C, and a resale price for Division B, the transfer price is calculated as follows:

$$\begin{aligned}\text{Resale price} &= \text{Transfer price} + (\text{Markup percentage} \times \text{Transfer price})\\ \$42 &= 1.40 \times \text{Transfer price}\\ \text{Transfer price} &= \$42/1.40\\ &= \$30\end{aligned}$$

3. $$\begin{aligned}\text{Cost-plus transfer price} &= \text{Manufacturing cost} + \text{Freight and insurance}\\ &= \$20 + \$5\\ &= \$25\end{aligned}$$

4. If freight and insurance decreased by $1, the comparable uncontrolled price and the cost-plus price would be $1 lower.

Summary of Learning Objectives

1. Define responsibility accounting, and describe the four types of responsibility centres.

- Responsibility accounting is a system that measures the results of each responsibility centre and compares those results with some expected or budgeted outcome.
- In a decentralized organization, lower-level managers make and implement decisions; in a centralized organization, lower-level managers are responsible only for implementing decisions.
- Four types of responsibility centres are:
  - Cost centres—manager is responsible for costs.
  - Revenue centres—manager is responsible for price and quantity sold.
  - Profit centres—manager is responsible for costs and revenues.
  - Investment centres—manager is responsible for costs, revenues, and investment.

2. Explain why firms choose to decentralize.

- Local managers can make better decisions using local information.
- Local managers can also provide a more timely response to changing conditions.
- Cognitive limitations make it difficult for any one central manager to be fully knowledgeable about all products and markets.
- Decentralization permits training and motivating local managers.
- Top management is free to spend time on longer-range activities, such as strategic planning.
- Decentralizations enhance competition among the divisions.

3. Compute and explain return on investment (ROI), residual income (RI), and economic value added (EVA).

- ROI is the ratio of operating income to average operating assets.
- Margin is operating income divided by sales *or* margin times turnover.
- Turnover is sales divided by average operating assets.
- Advantage: ROI encourages managers to focus on improving sales, controlling costs, and using assets efficiently.
- Disadvantage: ROI can encourage managers to sacrifice long-run benefits for the short run.
- Residual income (RI) is operating income minus a minimum percentage cost of capital times capital employed.
  - If $RI > 0$, then the division is earning more than the minimum cost of capital.
  - If $RI < 0$, then the division is earning less than the minimum cost of capital.
  - If $RI = 0$, then the division is earning just the minimum cost of capital.
- Economic value added is *after-tax* operating profit minus the *actual* total annual cost of capital.
  - If $EVA > 0$, then the company is creating wealth.
  - If $EVA < 0$, then the company is destroying capital.

4. Discuss methods of evaluating and rewarding managerial performance.

- Goal congruence means that the goals of the manager are aligned with the goals of the company.
- Firms encourage goal congruence by constructing management compensation programs that reward managers for taking actions that benefit the firm. These programs can include:
  - Salary
  - Bonuses

  - Stock options
  - Noncash benefits (perquisites)
- The accountant in the international firm faces the ambiguous and ever-changing nature of global business.
- The accountant in the multinational company (MNC) must stay up to date on numerous business areas including:
  - Information systems
  - Marketing
  - Management
  - Political and legal factors
  - Economics
  - The financial accounting rules of the countries in which his or her firm operates

5. Explain the role of transfer pricing in a decentralized firm.

- When one division of a company produces a product that can be used in production by another division, transfer pricing exists.
- A transfer price is the price charged by one division of a company to another division of the same company.
- The transfer price is revenue to the selling division and cost to the buying division.

6. Discuss the methods of setting transfer prices.

- Three methods are commonly used to set transfer prices:
  - Market-based price
  - Cost-based price
  - Negotiated price
- The buying division sets the maximum transfer price.
- The selling division sets the minimum transfer price.
- MNCs with subsidiaries in both high- and low-tax countries may use transfer prices to minimize income taxes.
- The CRA accepts three transfer pricing policies:
  - Comparable uncontrolled price method
  - Resale price method
  - Cost-plus method

CORNERSTONES FOR CHAPTER 10

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CORNERSTONE 10-6 The HOW and WHY of using the comparable uncontrolled price method and the resale price method in calculating transfer prices, page 520

Review Problems

I. Transfer Pricing

The Components Division produces a part that is used by the Goods Division. The cost of manufacturing the part is as follows:

Direct materials	$10
Direct labour	2
Variable overhead	3
Fixed overhead*	5
Total cost	$20

*Based on a practical volume of 200,000 parts.

Other costs incurred by the Components Division are as follows:

Fixed selling and administrative expense	$500,000
Variable selling expense	$1 per unit

The part usually sells for between $28 and $30 in the external market. Currently, the Components Division is selling it to external customers for $29. The division is capable of producing 200,000 units of the part per year; however, because of a weak economy, only 150,000 parts are expected to be sold during the coming year. The variable selling expenses are avoidable if the part is sold internally.

The Goods Division has been buying the same part from an external supplier for $28. It expects to use 50,000 units of the part during the coming year. The manager of the Goods Division has offered to buy 50,000 units from the Components Division for $18 per unit.

Required:

1. Determine the minimum transfer price that the Components Division would accept.
2. Determine the maximum transfer price that the manager of the Goods Division would pay.
3. Should an internal transfer take place? Why or why not? If you were the manager of the Components Division, would you sell the 50,000 components for $18 each? Explain.
4. Suppose that the average operating assets of the Components Division total $10 million. Compute the ROI for the coming year, assuming that the 50,000 units are transferred to the Goods Division for $21 each.

Solution:

1. The minimum transfer price is $15. The Components Division has idle capacity and so must cover only its incremental costs, which are the variable manufacturing costs. (Fixed costs are the same whether or not the internal transfer occurs; the variable selling expenses are avoidable.)
2. The maximum transfer price is $28. The Goods Division would not pay more for the part than the price it would have to pay an external supplier.
3. Yes, an internal transfer ought to occur; the opportunity cost of the selling division is less than the opportunity cost of the buying division. The Components Division would earn an additional $150,000 profit ($3 × 50,000). The total joint benefit, however, is $650,000 ($13 × 50,000). The manager of the Components Division should attempt to negotiate a more favourable outcome for that division.
4. Income statement:

Sales [($29 × 150,000) + ($21 × 50,000)]	$ 5,400,000
Less: Variable cost of goods sold ($15 × 200,000)	(3,000,000)
Variable selling expenses ($1 × 150,000)	(150,000)
Contribution margin	2,250,000
Less: Fixed overhead ($5 × 200,000)	(1,000,000)
Fixed selling and administrative	(500,000)
Operating income	$ 750,000

$$\begin{aligned}\text{ROI} &= \text{Operating income/Average operating assets}\\ &= \$750{,}000/\$10{,}000{,}000\\ &= 0.075\end{aligned}$$

II. EVA

Surfit Company, which manufactures surfboards, has been in business for six years. Sam Foster, owner of Surfit, is pleased with the firm's profit picture and is considering taking the company public (i.e., selling stock in Surfit on the Toronto exchange). Data for the past year are as follows:

After-tax operating income	$ 250,000
Total capital employed	1,060,000
Long-term debt (interest at 9%)	100,000
Owner's equity	900,000

Surfit Company pays taxes at the rate of 35 percent.

Required:

1. Calculate the weighted average cost of capital, assuming that owner's equity is valued at the average cost of common stock of 12 percent. Calculate the total cost of capital for Surfit Company last year.
2. Calculate EVA for Surfit Company.

Solution:

1.

	Amount	Percent	×	After-Tax Cost	=	Weighted Cost
Long-term debt	$ 100,000	0.10		0.0585*		0.0059
Owner's equity	900,000	0.90		0.1200		0.1080
Total	$1,000,000					0.1139

*$0.09 \times (1 - 0.035) = 0.0585$

The weighted average cost of capital is 11.39 percent.

The cost of capital last year = $0.1139 \times \$1{,}060{,}000 = \$120{,}734$.

2. EVA = $\$250{,}000 - \$120{,}734 = \$129{,}266$

Key Terms

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Discussion Questions

1. What is decentralization? Discuss the differences between centralized and decentralized decision making.
2. Explain why firms choose to decentralize.
3. Explain how access to local information can improve decision making.
4. What are margin and turnover? Explain how these concepts can improve the evaluation of an investment centre.
5. What are the three benefits of ROI? Explain how each can lead to improved profitability.
6. What are two disadvantages of ROI? Explain how each can lead to decreased profitability.
7. What is residual income? Explain how residual income overcomes one of ROI's disadvantages.
8. What is EVA? How does it differ from ROI and residual income?
9. What is a stock option? How can it encourage goal congruence?
10. What is a transfer price?
11. What is the transfer pricing problem?
12. If the minimum transfer price of the selling division is less than the maximum transfer price of the buying division, the intermediate product should be transferred internally. Do you agree or disagree? Why?
13. If an outside, perfectly competitive market exists for the intermediate product, what should the transfer price be? Why?
14. Identify three cost-based transfer prices. What are the disadvantages of cost-based transfer prices? When might it be appropriate to use cost-based transfer prices?

Cornerstone Exercises

OBJECTIVE 3
CORNERSTONE 10-1
SERVICE

Cornerstone Exercise 10-1 CALCULATING AVERAGE OPERATING ASSETS, MARGIN, TURNOVER, RETURN ON INVESTMENT (ROI)

Chester Inc. provided the following information for two of its divisions for last year:

	Paper Products Division	Chemicals Division
Sales	$29,375,000	$32,400,000
Operating income	2,350,000	1,296,000
Operating assets, January 1	6,000,000	14,000,000
Operating assets, December 31	5,750,000	13,000,000

Required:

1. For the Paper Products Division, calculate:
   a. Average operating assets
   b. Margin
   c. Turnover
   d. Return on investment (ROI)
2. For the Chemicals Division, calculate:
   a. Average operating assets
   b. Margin
   c. Turnover
   d. Return on investment (ROI)

3. ***What if*** operating income for the Paper Products Division was $2,000,000? How would that affect average operating assets? Margin? Turnover? ROI? Calculate any changed ratios (round to four significant digits).

OBJECTIVE 3
CORNERSTONE 10-2
SERVICE

Cornerstone Exercise 10-2 CALCULATING RESIDUAL INCOME

Refer to **Cornerstone Exercise 10-1**. Chester Inc. requires a 10 percent minimum rate of return.

Required:

1. Calculate residual income for the Paper Products Division.
2. Calculate residual income for the Chemicals Division.
3. ***What if*** the minimum required rate of return was 8 percent? How would that affect the residual income of the two divisions?

OBJECTIVE 3
CORNERSTONE 10-3

Cornerstone Exercise 10-3 CALCULATING WEIGHTED AVERAGE COST OF CAPITAL AND ECONOMIC VALUE ADDED (EVA)

Duhamel Industries Inc. had after-tax operating income last year of $1,996,500. Three sources of financing were used by the company: $4 million of mortgage bonds paying 8 percent interest, $5 million of unsecured bonds paying 10 percent interest, and $11 million in common stock, which was considered to be relatively risky (with a risk premium of 8 percent). The rate on long-term treasuries is 6 percent. Duhamel Industries Inc. pays a marginal tax rate of 40 percent.

Required:

1. Calculate the after-tax cost of each method of financing.
2. Calculate the weighted average cost of capital for Duhamel Industries Inc. Calculate the total dollar amount of capital employed for Duhamel Industries Inc.
3. Calculate economic value added (EVA) for Duhamel Industries Inc. for last year. Is the company creating or destroying wealth?
4. ***What if*** Duhamel Industries Inc. had common stock that was less risky than other stocks and commanded a risk premium of 5 percent? How would that affect the weighted average cost of capital? How would it affect EVA?

OBJECTIVE 6
CORNERSTONE 10-4

Cornerstone Exercise 10-4 DETERMINING MARKET-BASED AND NEGOTIATED TRANSFER PRICES

Deng Inc. has a number of divisions, including Aberdeen Division, producer of surgical blades, and Fairfield Division, a manufacturer of medical instruments.

Aberdeen Division produces a 2.6 cm steel blade that can be used by Fairfield Division in the production of scalpels. The market price of the blade is $22.60. Cost information for the blade is:

Variable product cost	$12.40
Fixed cost	7.00
Total product cost	$19.40

Fairfield needs 15,000 units of the 2.6 cm blade per year. Aberdeen Division is at full capacity (90,000 units of the blade).

Required:

1. If Deng Inc. has a transfer pricing policy that requires transfer at market price, what would the transfer price be? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer at that price?
2. Now suppose that Deng Inc. allows negotiated transfer pricing and that Aberdeen Division can avoid $1.75 of selling and distribution expense by selling to Fairfield Division. Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer somewhere in the bargaining range?

3. ***What if*** Aberdeen Division plans to produce and sell only 65,000 units of the 2.6 cm blade next year? Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer somewhere in the bargaining range?

Cornerstone Exercise 10-5 DETERMINING MARKET-BASED AND NEGOTIATED TRANSFER PRICES

OBJECTIVE 6
CORNERSTONE 10-5

Refer to **Cornerstone Exercise 10-4**.

Required:

1. If Deng Inc. has a transfer pricing policy that requires transfer at full product cost, what would the transfer price be? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer at that price?
2. If Deng Inc. has a transfer pricing policy that requires transfer at full cost plus 25 percent, what would the transfer price be? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer at that price?
3. If Deng Inc. has a transfer pricing policy that requires transfer at variable product cost plus a fixed fee of $2.00 per unit, what would the transfer price be? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer at that price?
4. ***What if*** Aberdeen Division plans to produce and sell only 65,000 units of the 2.6 cm blade next year? The Deng Inc. policy is that all transfers be at full cost. Which division sets the minimum transfer price, and what is it? Which division sets the maximum transfer price, and what is it? Do you suppose that Aberdeen and Fairfield divisions would choose to transfer?

Cornerstone Exercise 10-6 DETERMINING MARKET-BASED AND NEGOTIATED TRANSFER PRICES

OBJECTIVE 6
CORNERSTONE 10-6

Dalloway Inc. has a number of divisions around the world. Division CA (in Canada) purchases a component from Division ND (in the Netherlands). The component can be purchased externally for $18.50 each. The freight and insurance on the item amount to $1.90; however, commissions of $0.95 need not be paid.

Required:

1. Calculate the transfer price using the comparable uncontrolled price method.
2. Suppose that there is no outside market for the component that Division ND transfers to Division CA. Further assume that Division CA sells the component for $22.10 and normally receives a 30 percent markup on cost of goods sold. Calculate the transfer price using the resale price method.
3. Now assume that there is no external market for the component transferred from Division ND to Division CA, and that the component is used in the manufacture of another product (i.e., it is not resold). Calculate the transfer price using the cost-plus method. Further assume that Division ND's manufacturing cost for the component is $16.30.
4. ***What if*** commissions avoided were $2 per unit? How would that affect the comparable uncontrolled price? The resale price? The cost-plus price?

Exercises

Exercise 10-7 ROI, MARGIN, TURNOVER

OBJECTIVE 3

Pirelli Inc. presented two years of data for its Clothing Division and its Camping Division.

Clothing Division:	Year 1	Year 2
Sales	$3,400,000	$3,750,000
Operating income	190,400	191,250
Average operating assets	1,062,500	1,062,500

(*continued*)

Camping Division:

	Year 1	Year 2
Sales	$2,600,000	$2,680,000
Operating income	119,600	107,200
Average operating assets	1,000,000	1,000,000

Required:

1. Compute the ROI and the margin and turnover ratios for each year for the Clothing Division. (Round your answers to four significant digits.)
2. Compute the ROI and the margin and turnover ratios for each year for the Camping Division. (Round your answers to four significant digits.)
3. Explain the change in ROI from Year 1 to Year 2 for each division.

OBJECTIVE 3

Exercise 10-8 ROI AND INVESTMENT DECISIONS

Refer to **Exercise 10-7** for data. At the end of Year 2, the manager of the Camping Division is concerned about the division's performance. As a result, he is considering the opportunity to invest in two independent projects. The first is called the "Ever-Tent"; it is a small two-person tent capable of withstanding the high winds at the top of Mt. Everest. While the market for actual Everest climbers is small, the manager expects that well-to-do weekend campers will buy it due to the cachet of the name and its light weight. The second is a "KiddieKamp" kit which includes a child-sized sleeping bag and a colourful pup tent that can be set up easily in one's backyard. Without the investments, the division expects that Year 2 data will remain unchanged. The expected operating incomes and the outlay required for each investment are as follows:

	Ever-Tent	KiddieKamp
Operating income	$ 5,500	$ 3,800
Outlay	50,000	40,000

Pirelli's corporate headquarters has made available up to $100,000 of capital for this division. Any funds not invested by the division will be retained by headquarters and invested to earn the company's minimum required rate of return, 9 percent.

Required:

1. Compute the ROI for each investment.
2. Compute the divisional ROI (rounded to four significant digits) for each of the following four alternatives:
   a. The Ever-Tent is added.
   b. The KiddieKamp is added.
   c. Both investments are added.
   d. Neither investment is made; the status quo is maintained.

   Assuming that divisional managers are evaluated and rewarded on the basis of ROI performance, which alternative do you think the divisional manager will choose?

OBJECTIVE 3

Exercise 10-9 RESIDUAL INCOME AND INVESTMENT DECISIONS

Refer to the data given in **Exercise 10-8.**

Required:

1. Compute the residual income for each of the opportunities. (Round to the nearest dollar.)
2. Compute the divisional residual income (rounded to the nearest dollar) for each of the following four alternatives:
   a. The Ever-Tent is added.
   b. The KiddieKamp is added.
   c. Both investments are added.
   d. Neither investment is made; the status quo is maintained.

Assuming that divisional managers are evaluated and rewarded on the basis of residual income, which alternative do you think the divisional manager will choose?

3. Based on your answer in Requirement 2, compute the profit or loss from the divisional manager's investment decision. Was the correct decision made?

Exercise 10-10 CALCULATING EVA

OBJECTIVE 3

Mortimer Company manufactures elderberry wine. Last year, Mortimer earned operating income of $206,000 after income taxes. Capital employed equalled $2 million. Mortimer is 60 percent equity and 40 percent 10-year bonds paying 5 percent interest. Mortimer's marginal tax rate is 40 percent. The company is considered a fairly risky investment and probably commands a 12-point premium above the 6 percent rate on long-term T-bills.

Jonathan Mortimer's aunts, Abby and Martha, have just retired, and Mortimer is the new CEO of Mortimer Company. He would like to improve EVA for the company. Compute EVA under each of the following independent scenarios that Mortimer is considering. (Use a spreadsheet to perform your calculations and round all percentage figures to four significant digits.)

Required:

1. No changes are made; calculate EVA using the original data.
2. Sugar will be used to replace another natural ingredient (atomic number 33) in the elderberry wine. This should not affect costs but will begin to affect the market assessment of Mortimer Company, bringing the premium above long-term T-bills to 10 percent the first year and 7 percent the second year. Calculate revised EVA for both years.
3. Mortimer is considering expanding but needs additional capital. The company could borrow money, but it is considering selling more common stock, which would increase equity to 80 percent of total financing. Total capital employed would be $3,000,000. The new after-tax operating income would be $450,000. Using the original data, calculate EVA. Then, recalculate EVA assuming the materials substitution described in Requirement 2. New after-tax income will be $450,000, and in Year 1, the premium will be 10 percent above the long-term rate. In Year 2, it will be 7 percent above the long-term rate. (*Hint:* You will calculate three EVAs for this requirement.)

Exercise 10-11 OPERATING INCOME FOR SEGMENTS

OBJECTIVE 3

Venpool Inc. manufactures and sells cooktops and ovens through three divisions: Home, Restaurant, and Specialty. Each division is evaluated as a profit centre. Data for each division for last year are as follows (numbers in thousands):

	Home	Restaurant	Specialty
Sales	$3,450	$3,000	$2,100
Cost of goods sold	2,400	2,200	1,400
Selling and administrative expenses	840	370	250

The income tax rate for Venpool Inc. is 30 percent. Venpool Inc. has two sources of financing: bonds paying 6 percent interest, which account for 30 percent of total investment, and equity accounting for the remaining 70 percent of total investment. Venpool Inc. has been in business for over 15 years and is considered a relatively stable stock, despite its link to the cyclical construction industry. As a result, Venpool stock has an opportunity cost of 5 percent over the 6 percent long-term government bond rate. Venpool's total capital employed is $3.34 million ($2,100,000 for the Home Division, $700,000 for the Restaurant Division, and the remainder for the Specialty Division).

Required:

1. Prepare a segmented income statement for Venpool Inc. for last year.
2. Calculate Venpool's weighted average cost of capital. (Round to four significant digits.)

3. Calculate EVA for each division and for Venpool Inc.
4. Comment on the performance of each of the divisions.

OBJECTIVE 5 6

Exercise 10-12 TRANSFER PRICING, IDLE CAPACITY

Mouton & Perrier Inc. has a number of divisions that produce liquors, bottled water, and glassware. The Glassware Division manufactures a variety of bottles which can be sold externally (to soft-drink and juice bottlers) or internally to Mouton & Perrier's Bottled Water Division. Sales and cost data on a case of 24 basic 1 litre bottles are as follows:

Unit selling price	$2.95
Unit variable cost	$1.25
Unit product fixed cost*	$0.70
Practical capacity in cases	500,000

*$350,000/500,000

During the coming year, the Glassware Division expects to sell 390,000 cases of this bottle. The Bottled Water Division currently plans to buy 100,000 cases on the outside market for $2.95 each. Ellyn Burridge, manager of the Glassware Division, approached Justin Thomas, manager of the Bottled Water Division, and offered to sell the 100,000 cases for $2.89 each. Ellyn explained to Justin that she can avoid selling costs of $0.12 per case by selling internally and that she would split the savings by offering a $0.06 discount on the usual price.

Required:

1. What is the minimum transfer price that the Glassware Division would be willing to accept? What is the maximum transfer price that the Bottled Water Division would be willing to pay? Should an internal transfer take place? What would be the benefit (or loss) to the firm as a whole if the internal transfer takes place?
2. Suppose Justin knows that the Glassware Division has idle capacity. Do you think that he would agree to the transfer price of $2.89? Suppose he counters with an offer to pay $2.40. If you were Ellyn, would you be interested in this price? Explain with supporting computations.
3. Suppose that Mouton & Perrier's policy is that all internal transfers take place at full manufacturing cost. What would the transfer price be? Would the transfer take place?

OBJECTIVE 6

Exercise 10-13 TRANSFER PRICING

Comfort Furniture Manufacturing Inc. has a division in Canada that produces and sells furniture for discount furniture stores. One type of sofa is made in the International Division in China. The sofas are sold externally in Canada for $250 each. It costs $7.50 per sofa for shipping and $10 per sofa for import duties. When the sofas are sold externally, Comfort Furniture Manufacturing spends $25 each for commissions and an average of $1.30 per sofa for advertising.

Required:

1. Which CRA method should be used to calculate the allowable transfer price?
2. Using the appropriate CRA method, calculate the transfer price.

OBJECTIVE 6

Exercise 10-14 TRANSFER PRICING

Desant Inc. has a division in Indonesia that makes dyestuff in a variety of colours used to dye denim for jeans, and another division in Canada that manufactures denim clothing. The Dyestuff Division incurs manufacturing costs of $3.76 for one kilogram of powdered dye.

The Clothing Division currently buys its dye powder from an outside supplier for $4.10 per kilogram. If the Clothing Division purchases the powder from the Indonesian division, the shipping costs will be $0.16 per kilogram, but sales commissions of $0.04 per kilogram will be avoided with an internal transfer.

Required:

1. Which Section 482 method should be used to calculate the allowable transfer price? Calculate the appropriate transfer price per kilogram.
2. Assume that the Clothing Division cannot buy this type of powder externally since it has an unusual formula that results in a colour particular to Desant's jeans. Which CRA method should be used to calculate the allowable transfer price? Calculate the appropriate transfer price per kilogram.

Exercise 10-15 TRANSFER PRICING

OBJECTIVE 6

Rao Inc. has a division in Canada that makes paint. Rao has another U.S. division, the Retail Division, that operates a chain of home improvement stores. The Retail Division would like to buy the unique, long-lasting paint from the Canadian division, since this type of paint is not currently available. The Paint Division incurs manufacturing costs of $4.12 for 1 litre of paint.

If the Retail Division purchases the paint from the Canadian division, the shipping costs will be $0.40 per litre, but sales commissions of $0.60 per litre will be avoided with an internal transfer. The Retail Division plans to sell the paint for $11.68 per litre. Normally, the Retail Division earns a gross margin of 60 percent above cost of goods sold.

Required:

1. Which CRA method should be used to calculate the allowable transfer price?
2. Calculate the appropriate transfer price per litre.

Exercise 10-16 ROI AND RESIDUAL INCOME

OBJECTIVE 3

A multinational corporation has a number of divisions, two of which are the North American Division and the South American Division. Data on the two divisions are as follows:

	North American	South American
Average operating assets	5,000,000	3,900,000
Operating income	618,000	397,500
Minimum required return	10%	10%

Round all rates of return to four significant digits.

Required:

1. Compute residual income for each division. By comparing residual income, is it possible to make a useful comparison of divisional performance? Explain.
2. Compute the residual rate of return by dividing the residual income by the average operating assets. Is it possible now to say that one division outperformed the other? Explain.
3. Compute the return on investment for each division. Can we make meaningful comparisons of divisional performance? Explain.
4. Add the residual rate of return computed in Requirement 2 to the required rate of return. Compare these rates with the ROI computed in Requirement 3. Will this relationship always be the same?

Exercise 10-17 MARGIN, TURNOVER, ROI

OBJECTIVE 3

Consider the data for each of the following four independent companies:

	A	B	C	D
Revenue	$10,000	$48,000	$96,000	?
Expenses	$8,000	?	$90,000	?
Operating income	$2,000	$12,000	?	?
Assets	$40,000	?	$48,000	$9,600
Margin	?	25%	?	6.25%
Turnover	?	0.50	?	2.00
ROI	?	?	?	?

Required:

1. Calculate the missing values in the above table.
2. Assume that the cost of capital is 9 percent for each of the four firms. Compute the residual income for each of the four firms.

OBJECTIVE 3

SERVICE

Exercise 10-18 ROI, RESIDUAL INCOME

The following selected data pertain to the Argent Division for last year:

Sales	$1,000,000
Variable costs	$624,000
Traceable fixed costs	$100,000
Average invested capital	$1,500,000
Imputed interest rate	15%

Required:

1. How much is the residual income?
2. How much is the return on investment? (Rounded to four significant digits.)

OBJECTIVE 4

SERVICE

Exercise 10-19 STOCK OPTIONS

Fermat Inc. has acquired two new companies, one in consumer products and the other in financial services. Fermat's top management believes that the executives of the two newly acquired companies can be most quickly assimilated into the parent company if they own shares of Fermat stock. Accordingly, on April 1, Fermat approved a stock option plan whereby each of the top four executives of the new companies could purchase up to 20,000 shares of Fermat stock at $15 per share. The option will expire in five years.

Required:

1. If Fermat stock rises to $26.50 per share by December 1, what is the value of the option to each executive?
2. Discuss some of the advantages and disadvantages of the Fermat stock option plan.

Problems

OBJECTIVE 4

SERVICE

Problem 10-20 BONUSES AND STOCK OPTIONS

Lawanna Davis graduated from Eastern University with a major in accounting five years ago. She obtained a position with a well-known professional services firm upon graduation and has become one of their outstanding performers. In the course of her work, she has developed numerous contacts with business firms in the area. One of them, Bumaby Inc. recently offered her a position as head of their Financial Services Division. The offer includes a salary of $50,000 per year, annual bonuses of 1 percent of divisional operating income, and a stock option for 10,000 shares of Bumaby stock to be exercised at $15 per share in two years. Last year, the Financial Services Division earned $1,110,000. This year, it is budgeted to earn $1,600,000. Bumaby stock has increased in value at the rate of 16 percent per year over the past five years. Lawanna currently earns $65,000.

Required:

Advise Lawanna on the relative merits of the Bumaby offer.

OBJECTIVE 5 6

Problem 10-21 SETTING TRANSFER PRICES—MARKET PRICE VERSUS FULL COST

Omicron Inc. manufactures heating and air conditioning units in its six divisions. One division, the Components Division, produces electronic components that can be used by the other five. All the components produced by this division can be sold to outside customers; however, from the beginning, about 70 percent of its output has been used internally. The current policy requires that all internal transfers of components be transferred at full cost.

Recently, Cynthia Busby, the new chief executive officer of Omicron, decided to investigate the transfer pricing policy. She was concerned that the current method of pricing internal transfers might force decisions by divisional managers that would be suboptimal for the firm. As part of her inquiry, she gathered some information concerning Part 4CM, used by the Small AC Division in its production of a window air conditioner, Model 7AC.

The Small AC Division sells 100,000 units of Model 7AC each year at a unit price of $58. Given current market conditions, this is the maximum price that the division can charge for Model 7AC. The cost of manufacturing the air conditioner is computed as follows:

Part 4CM	$ 6.45
Direct materials	23.00
Direct labour	15.00
Variable overhead	3.50
Fixed overhead	6.50
Total unit cost	$54.45

The window unit is produced efficiently, and no further reduction in manufacturing costs is possible.

The manager of the Components Division indicated that he could sell 10,000 units (the division's capacity for this part) of Part 4CM to outside buyers at $12 per unit. The Small AC Division could also buy the part for $12 from external suppliers. The following detail on the manufacturing cost of the component was provided:

Direct materials	$2.75
Direct labour	0.80
Variable overhead	1.10
Fixed overhead	1.80
Total unit cost	$6.45

Required:

1. Compute the firmwide contribution margin associated with Part 4CM and Model 7AC. Also, compute the contribution margin earned by each division.
2. Suppose that Cynthia Busby abolishes the current transfer pricing policy and gives divisions autonomy in setting transfer prices. Can you predict what transfer price the manager of the Components Division will set? What should be the minimum transfer price for this part? The maximum transfer price?
3. Given the new transfer pricing policy, predict how this will affect the production decision for Model 7AC of the manager of the Small AC Division. How many units of Part 4CM will the manager of the Small AC Division purchase, either internally or externally?
4. Given the new transfer price set by the Components Division and your answer to Requirement 3, how many units of Part 4CM will be sold externally?
5. Given your answers to Requirements 3 and 4, compute the firmwide contribution margin. What has happened? Was Cynthia's decision to grant additional decentralization good or bad?

Problem 10-22 TRANSFER PRICING WITH IDLE CAPACITY

OBJECTIVE 3 5 6

SERVICE

Oriole Inc. owns a number of food service companies. Two divisions are the Coffee Division and the Donut Shop Division. The Coffee Division purchases and roasts coffee beans for sale to supermarkets and specialty shops. The Donut Shop Division operates a chain of donut shops where the donuts are made on the premises. Coffee is an important item for sale along with the donuts and, to date, has been purchased from the Coffee Division. Company policy permits each manager the freedom to decide whether or not to buy or sell internally. Each divisional manager is evaluated on the basis of return on investment and residual income.

Recently, an outside supplier has offered to sell coffee beans, roasted and ground, to the Donut Shop Division for $4.30 per kilogram. Since the current price paid to the

Coffee Division is $4.75 per kilogram, Ashleigh Tremont, the manager of the Donut Shop Division, was interested in the offer. However, before making the decision to switch to the outside supplier, she decided to approach Santigui Melendez, manager of the Coffee Division, to see if he wanted to offer an even better price. If not, then Ashleigh would buy from the outside supplier.

Upon receiving the information from Ashleigh about the outside offer, Santigui gathered the following information about the coffee:

Direct materials	$0.95
Direct labour	0.45
Variable overhead	0.72
Fixed overhead*	1.53
Total unit cost	$3.65

*Fixed overhead is based on $1,530,000/1,000,000 kilograms.

Selling price per kilogram	$4.75
Production capacity	1,000,000 kilograms
Internal sales	100,000 kilograms

Required:

1. Suppose that the Coffee Division is producing at capacity and can sell all that it produces to outside customers. How should Santigui respond to Ashleigh's request for a lower transfer price? What will be the effect on firmwide profits? Compute the effect of this response on each division's profits.
2. Now, assume that the Coffee Division is currently selling 950,000 kilograms. If no units are sold internally, total coffee sales will drop to 850,000 kilograms. Suppose that Santigui refuses to lower the transfer price from $4.75 and the Donut Division purchases from the external supplier. Compute the effect on each division's profits and on the profits of the firm as a whole.
3. Refer to Requirement 2. What are the minimum and maximum transfer prices? Suppose that the transfer price is set at the maximum price less $1. Will the two divisions accept this transfer price? Compute the effect on the firm's profits and on each division's profits.
4. Suppose that the Coffee Division has operating assets of $2,000,000. Assume that the Coffee Division sells 850,000 kilograms to outsiders and 100,000 kilograms to the Donut Division at a price of $4.75 per kilogram. What is divisional ROI (rounded to four significant digits) based on this situation? Now, refer to Requirement 3. What will divisional ROI (rounded to four significant digits) be if the transfer price of the maximum price less $1 is implemented? How will the change in ROI affect Santigui? What information has he gained as a result of the transfer pricing negotiations?

OBJECTIVE ➤ 5 6

Problem 10-23 TRANSFER PRICING: VARIOUS COMPUTATIONS

Corning Company has a decentralized organization with a divisional structure. Two of these divisions are the Appliance Division and the Manufactured Housing Division. Each divisional manager is evaluated on the basis of ROI.

The Appliance Division produces a small automatic dishwasher that the Manufactured Housing Division can use in one of its models. Appliance can produce up to 20,000 of these dishwashers per year. The variable costs of manufacturing the dishwashers are $98. The Manufactured Housing Division inserts the dishwasher into the model house and then sells the manufactured house to outside customers for $73,000 each. The division's capacity is 4,000 units. The variable costs of the manufactured house (in addition to the cost of the dishwasher itself) are $42,600.

Required:

Assume each part is independent, unless otherwise indicated.

1. Assume that all of the dishwashers produced can be sold to external customers for $320 each. The Manufactured Housing Division wants to buy 4,000 dishwashers per year. What should the transfer price be?

2. Refer to Requirement 1. Assume $24 of avoidable distribution costs. Identify the maximum and minimum transfer prices. Identify the actual transfer price, assuming that negotiation splits the difference.
3. Assume that the Appliance Division is operating at 75 percent capacity. The Manufactured Housing Division is currently buying 4,000 dishwashers from an outside supplier for $290 each. Assume that any joint benefit will be split evenly between the two divisions. What is the expected transfer price? How much will the profits of the firm increase under this arrangement? How much will the profits of the Appliance Division increase, assuming that it sells the extra 4,000 dishwashers internally?

Problem 10-24 MANAGEMENT COMPENSATION

OBJECTIVE 4

Dorian Inc., a truck manufacturing conglomerate, has recently purchased two divisions: Meyers Service Company and Wellington Products Inc. Meyers provides maintenance service on large truck cabs for 10-wheeler trucks, and Wellington produces air brakes for the 10-wheeler trucks.

The employees at Meyers take pride in their work, as Meyers is proclaimed to offer the best maintenance service in the trucking industry. The management of Meyers, as a group, has received additional compensation from a 10 percent bonus pool based on income before income taxes and bonus. Dorian plans to continue to compensate the Meyers management team on this basis as it is the same incentive plan used for all other Dorian divisions, except for the Wellington division.

Wellington offers a high-quality product to the trucking industry and is the premium choice even when compared to foreign competition. The management team at Wellington strives for zero defects and minimal scrap costs; current scrap levels are at 2 percent. The incentive compensation plan for Wellington management has been a 1 percent bonus based on gross margin. Dorian plans to continue to compensate the Wellington management team on this basis.

The following condensed income statements are for both divisions for the fiscal year ended May 31, 2013:

Dorian Inc.
Divisional Income Statements
For the Year Ended May 31, 2013

	Meyers Service Company	Wellington Products Inc.
Revenues	$4,000,000	$10,000,000
Cost of product	75,000	4,950,000
Salaries*	2,200,000	2,150,000
Fixed selling expenses	1,000,000	2,500,000
Interest expense	30,000	65,000
Other operating expenses	278,000	134,000
Total expenses	3,583,000	9,799,000
Income before income taxes and bonus	$ 417,000	$ 201,000

*Each division has $1,000,000 of management salary expense that is eligible for the bonus pool.

Dorian has invited the management teams of all its divisions to an off-site management workshop in July where the bonus cheques will be presented. Dorian is concerned that the different bonus plans at the two divisions may cause some heated discussion.

Required:

1. Determine the 2013 bonus pool available for the management team at:
   a. Meyers Service Company
   b. Wellington Products Inc.
2. Identify at least two advantages and disadvantages to Dorian Inc. of the bonus pool incentive plan at:
   a. Meyers Service Company
   b. Wellington Products Inc.

3. Having two different types of incentive plans for two operating divisions of the same corporation can create problems.
   a. Discuss the behavioural problems that could arise within management for Meyers Service Company and Wellington Products Inc. by having different types of incentive plans.
   b. Present arguments that Dorian Inc. can give to the management teams of both Meyers and Wellington to justify having two different incentive plans.

OBJECTIVE 5

Problem 10-25 TRANSFER PRICING IN THE MNC

Carnover Inc. manufactures a broad line of industrial and consumer products. One of its plants is located in Madrid, Spain, and another in Singapore. The Madrid plant is operating at 85 percent capacity. Its main product, electric motors, has experienced softness in the market, which has led to predictions of further softening of the market and predictions of a decline in production to 65 percent capacity. If that happens, workers will have to be laid off and one wing of the factory closed. The Singapore plant manufactures heavy-duty industrial mixers that use the motors manufactured by the Madrid plant as an integral component. Demand for the mixers is strong. Price and cost information for the mixers are as follows:

Price	$2,200
Direct materials	630
Direct labour	125
Variable overhead	250
Fixed overhead	100

Fixed overhead is based on an annual budgeted amount of $3,500,000 and budgeted production of 35,000 mixers. The direct materials cost includes the cost of the motor at $200 (market price).

The Madrid plant capacity is 20,000 motors per year. Cost data are as follows:

Direct materials	$ 75
Direct labour	60
Variable overhead	60
Fixed overhead	100

Fixed overhead is based on budgeted fixed overhead of $2,000,000.

Required:

1. What is the maximum transfer price the Singapore plant would accept?
2. What is the minimum transfer price the Madrid plant would accept?
3. Consider the following environmental factors:

Madrid Plant	Singapore Plant
Full employment is very important.	Cheap labour is plentiful.
Local government prohibits layoffs without permission (which is rarely granted).	Accounting is based on Canadian model, oriented toward decision-making needs of creditors and investors.
Accounting is legalistic and conservative, designed to ensure compliance with government objectives.	

How might these environmental factors impact the transfer pricing decision?

OBJECTIVE 3

Problem 10-26 CASE ON ROI AND RESIDUAL INCOME, ETHICAL CONSIDERATIONS

Grate Care Company specializes in producing products for personal grooming. The company operates six divisions, including the Hair Products Division. Each division is treated as an investment centre. Managers are evaluated and rewarded on the basis of ROI performance. Only those managers who produce the best ROIs are selected to receive bonuses and to fill higher-level managerial positions. Fred

Auletta, manager of the Hair Products Division, has always been one of the top performers. For the past two years, Fred's division has produced the largest ROI; last year, the division earned an operating income of $2.56 million and employed average operating assets valued at $16 million. Fred is pleased with his division's performance and has been told that if the division does well this year, he will be in line for a headquarters position.

For the coming year, Fred's division has been promised new capital totalling $1.5 million. Any of the capital not invested by the division will be invested to earn the company's required rate of return (9 percent). After some careful investigation, the marketing and engineering staff recommended that the division invest in equipment that could be used to produce a crimping and waving iron, a product currently not produced by the division. The cost of the equipment was estimated at $1.2 million. The division's marketing manager estimated operating earnings from the new line to be $156,000 per year.

After receiving the proposal and reviewing the potential effects, Fred turned it down. He then wrote a memo to corporate headquarters, indicating that his division would not be able to employ the capital in any new projects within the next eight to 10 months. He did note, however, that he was confident that his marketing and engineering staff would have a project ready by the end of the year. At that time, he would like to have access to the capital.

Required:

1. Explain why Fred Auletta turned down the proposal to add the capability of producing a crimping and waving iron. Provide computations to support your reasoning.
2. Compute the effect that the new product line would have on the profitability of the firm as a whole. Should the division have produced the crimping and waving iron?
3. Suppose that the firm used residual income as a measure of divisional performance. Do you think Fred's decision might have been different? Why?
4. Explain why a firm like Grate Care might decide to use both residual income and return on investment as measures of performance.
5. Did Fred display ethical behaviour when he turned down the investment? In discussing this issue, consider why he refused to allow the investment.

CMA Problems

CMA Problem 10-1 TRANSFER PRICING*

OBJECTIVE 5 6

Fillmore Industries is a vertically integrated firm with several divisions that operate as decentralized profit centres. Fillmore's Systems Division manufactures scientific instruments and uses the products of two of Fillmore's other divisions. The Board Division manufactures printed circuit boards (PCBs). One PCB model is made exclusively for the Systems Division using proprietary designs, while less complex models are sold in outside markets. The products of the Transistor Division are sold in a well developed competitive market; however, one transistor model is also used by the Systems Division. The costs per unit of the products used by the Systems Division are as follows:

	PCB	Transistor
Direct materials	$1.85	$0.40
Direct labour	4.20	0.90
Variable overhead	2.40	0.70
Fixed overhead	0.85	0.75
Total cost	$9.30	$2.75

The Board Division sells its commercial product at full cost plus a 30 percent markup and believes the proprietary board made for the Systems Division would sell for $12 per unit on the open market. The market price of the transistor used by the Systems Division is $3.45 per unit.

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Required:

1. What is the minimum transfer price for the Transistor Division? What is the maximum transfer price of the transistor for the Systems Division?
2. Assume the Systems Division is able to purchase a large quantity of transistors from an outside source at $2.75 per unit. Further assume that the Transistor Division has excess capacity. Can the Transistor Division meet this price?
3. The Board and Systems divisions have negotiated a transfer price of $11 per printed circuit board. Discuss the impact this transfer price will have on each division. *(CMA adapted)*

OBJECTIVE 1 3 4

CMA Problem 10-2 ROI, RESIDUAL INCOME*

Radisson Industries produces tool and die machinery for manufacturers. The company expanded vertically in 2012 by acquiring one of its suppliers of alloy steel plates, Keimer Steel Company. To manage the two separate businesses, the operations of Keimer are reported separately as an investment centre.

Radisson monitors its divisions on the basis of both unit contribution and return on average investment (ROI), with investment defined as average operating assets employed. Management bonuses are determined on ROI. All investments in operating assets are expected to earn a minimum return of 13 percent before income taxes.

Keimer's cost of goods sold is considered to be entirely variable, while the division's administrative expenses are not dependent on volume. Selling expenses are a mixed cost with 40 percent attributed to sales volume. Keimer contemplated a capital acquisition with an estimated ROI of 14.5 percent; however, division management decided against the investment because it believed that the investment would decrease Keimer's overall ROI.

The 2013 operating statement for Keimer follows. The division's operating assets employed were $12,600,000 at November 30, 2013, a 5 percent increase over the 2012 year-end balance.

Keimer Steel Company
Operating Statement
For the Year Ended November 30, 2013
($000 omitted)

Sales revenue		$25,000
Less expenses:		
Cost of goods sold	$16,500	
Administrative expenses	3,955	
Selling expenses	2,700	23,155
Operating income before income taxes		$ 1,845

Required:

1. Calculate the unit contribution for Keimer Steel Company if 1,187,200 units were produced and sold during the year ended November 30, 2013.
2. Calculate the following performance measures for 2013 for Keimer Steel Company:
   a. Pretax return on average investment in operating assets employed (ROI).
   b. Residual income calculated on the basis of average operating assets employed.
3. Explain why the management of Keimer Steel Company would have been more likely to accept the contemplated capital acquisition if residual income rather than ROI were used as a performance measure.
4. Keimer Steel Company is a separate investment centre within Radisson Industries. Identify several items that Keimer should control if it is to be evaluated fairly by either the ROI or residual income performance measures. *(CMA adapted)*

CMA Problem 10-3 MANAGERIAL PERFORMANCE EVALUATION*

OBJECTIVE 1 2 3

Greg Petrov has recently been appointed vice president of operations for Webster Corporation. Greg has a manufacturing background and previously served as operations manager of Webster's Tractor Division. The business segments of Webster include the manufacture of heavy equipment, food processing, and financial services.

In a recent conversation with Carol Andrews, Webster's chief financial officer, Greg suggested that segment managers be evaluated on the basis of the segment data appearing in Webster's annual financial report. This report presents revenues, earnings, identifiable assets, and depreciation for each segment for a five-year period. Greg believes that evaluating segment managers by criteria similar to that used in evaluating the company's top management would be appropriate. Carol has expressed her reservations about using segment information from the annual financial report for this purpose and has suggested that Greg consider other ways to evaluate the performance of segment managers.

Required:

1. Explain why the segment information prepared for public reporting purposes may not be appropriate for the evaluation of segment management performance.
2. Describe the possible behavioural impact of Webster Corporation's segment managers if their performance is evaluated on the basis of the information in the annual financial report.
3. Identify and describe several types of financial information that would be more appropriate for Greg to review when evaluating the performance of segment managers. *(CMA adapted)*

CMA Problem 10-4 ROI, RESIDUAL INCOME, BEHAVIOURAL ISSUES*

OBJECTIVE 3

Jump Start Company (JSC), a subsidiary of Mason Industries, manufactures go-carts and other recreational vehicles. Family recreational centres that feature go-cart tracks along with miniature golf, batting cages, and arcade games have increased in popularity. As a result, JSC has been pressured by Mason management to diversify into some of these other recreational areas. Recreational Leasing, Inc. (RLI), one of the largest firms leasing arcade games to these family recreational centres, is looking for a friendly buyer. Mason's top management believes that RLI's assets could be acquired for an investment of $3.2 million and has strongly urged Bill Grieco, division manager of JSC, to consider acquiring RLI.

Bill has reviewed RLI's financial statements with his controller, Marie Donnelly, and they believe that the acquisition may not be in the best interest of JSC.

"If we decide not to do this, the Mason people are not going to be happy," said Bill. "If we could convince them to base our bonuses on something other than return on investment, maybe this acquisition would look more attractive. How would we do if the bonuses were based on residual income using the company's 15 percent cost of capital?"

Mason has traditionally evaluated all of its divisions on the basis of return on investment, which is defined as the ratio of operating income to total assets. The desired rate of return for each division is 20 percent. The management team of any division reporting an annual increase in the return on investment is automatically eligible for a bonus. The management of divisions reporting a decline in the return on investment must provide convincing explanations for the decline to be eligible for a bonus, and this bonus is limited to 50 percent of the bonus paid to divisions reporting an increase.

The following condensed financial statements are for both JSC and RLI for the fiscal year ended May 31, 2013:

	JSC	RLI
Sales revenue	$10,500,000	
Leasing revenue		$ 2,800,000
Variable expenses	(7,000,000)	(1,000,000)
Fixed expenses	(1,500,000)	(1,200,000)
Operating income	$ 2,000,000	$ 600,000
Current assets	$ 2,300,000	$ 1,900,000
Long-term assets	5,700,000	1,100,000
Total assets	$ 8,000,000	$ 3,000,000

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(continued)

	JSC	RLI
Current liabilities	$ 1,400,000	$ 850,000
Long-term liabilities	3,800,000	1,200,000
Shareholders' equity	2,800,000	950,000
Total liabilities and shareholders' equity	$ 8,000,000	$ 3,000,000

Required:

1. If Mason Industries continues to use return on investment as the sole measure of division performance, explain why JSC would be reluctant to acquire RLI. Be sure to support your answer with appropriate calculations.
2. If Mason Industries could be persuaded to use residual income to measure the performance of JSC, explain why JSC would be more willing to acquire RLI. Be sure to support your answer with appropriate calculations.
3. Discuss how the behaviour of division managers is likely to be affected by the use of:
   a. Return on investment as a performance measure
   b. Residual income as a performance measure *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at ***www.hansen1ce.nelson.com***.

Integrative Exercise 2

Part 2
Chapters 5–10

Beauville Furniture Corporation produces sofas, recliners, and lounge chairs. Beauville is located in a medium-sized community in southeastern Quebec. It is a major employer in the community. In fact, the economic well-being of the community is tied very strongly to Beauville. Beauville operates a sawmill, a fabric plant, and a furniture plant in the same community.

The sawmill buys logs from independent producers. The sawmill then processes the logs into four grades of lumber: firsts and seconds, No. 1 common, No. 2 common, and No. 3 common. All costs incurred in the mill are common to the four grades of lumber. All four grades of lumber are used by the furniture plant. The mill transfers everything it produces to the furniture plant, and the grades are transferred at cost. Trucks are used to move the lumber from the mill to the furniture plant. Although no outside sales exist, the mill could sell to external customers, and the selling prices of the four grades are known.

The fabric plant is responsible for producing the fabric that is used by the furniture plant. To produce three totally different fabrics (identified by fabric ID codes: FB60, FB70, and FB80, respectively), the plant has three separate production operations—one for each fabric. Thus, production of all three fabrics occurs at the same time in different locations in the plant. Each fabric's production operation has two processes: the weaving and pattern process, and the colouring and bolting process. In the weaving and pattern process, yarn is used to create yards of fabric with different designs. In the next process, the fabric is dyed, cut into 25-metre sections, and wrapped around cardboard rods to form 25-metre bolts. The bolts are transported by forklift to the furniture plant's Receiving Department. All of the output of the fabric plant is used by the furniture plant (to produce the sofas and chairs). For accounting purposes, the fabric is transferred at cost to the furniture plant.

The furniture plant produces orders for customers on a special-order basis. The customers specify the quantity, style, fabric, lumber grade, and pattern. Typically, jobs are large (involving at least 500 units). The plant has two production departments: Cutting and Assembly. In the Cutting Department, the fabric and wooden frame components are sized and cut. Other components are purchased from external suppliers and are removed from stores as needed for assembly. After the fabric and wooden components are finished for the entire job, they are moved to the Assembly Department. The Assembly Department takes the individual components and assembles the sofas (or chairs).

Beauville Furniture has been in business for over two decades and has a good reputation. However, during the past five years, Beauville experienced eroding profits and declining sales. Bids were increasingly lost (even aggressive bids) on the more popular models. Yet, the company was winning bids on some of the more-difficult-to-produce items. Louis Renaud, the owner and manager, was frustrated. He simply couldn't understand how some of his competitors could sell for such low prices. On a common sofa job involving 500 units, Beauville's bids were running $25 per unit, or $12,500 per job more than the winning bids (on average). Yet, on the more difficult items, Beauville's bids were running about $60 per unit less than the next closest bid. Giselle Boucher, vice president of finance, was assigned the task of preparing a cost analysis of the company's product lines. Louis wanted to know if the company's costs were excessive. Perhaps the company was being wasteful, and it was simply costing more to produce furniture than it was costing its competitors.

Giselle prepared herself by reading recent literature on cost management and product costing and attending several conferences that explored the same issues. She then reviewed the costing procedures of the company's mill and two plants and did a preliminary assessment of their soundness. The production costs of the mill were common to all lumber grades and were assigned using the physical units method. Since the output and production costs were fairly uniform throughout the year, the mill used an actual costing system. Although Giselle had no difficulty with actual costing, she decided to explore the effects of using the sales-value-at-split-off method. Thus, cost and production data for the mill were gathered so that an analysis could be conducted. The two plants used normal costing systems. The fabric plant used process costing, and the furniture plant used job-order costing. Both plants used plantwide overhead rates based on direct labour hours. Based on her initial reviews, she concluded that the costing procedures for the fabric plant were satisfactory. Essentially, there was no evidence of

product diversity. A statistical analysis revealed that about 90 percent of the variability in the plant's overhead cost could be explained by direct labour hours. Thus, the use of a plantwide overhead rate based on direct labour hours seemed justified. What did concern her, though, was the material waste that she observed in the plant. Maybe a standard cost system would be useful for increasing the overall cost efficiency of the plant. Consequently, as part of her report to Louis, she decided to include a description of the fabric plant's costing procedures—at least for one of the fabric types. She also decided to develop a standard cost sheet for the chosen fabric. The furniture plant, however, was a more difficult matter. Product diversity was present and could be causing some distortions in product costs. Furthermore, statistical analysis revealed that only about 40 percent of the variability in overhead cost was explained by the direct labour hours. She decided that additional analysis was needed so that a sound product costing method could be recommended. One possibility would be to increase the number of overhead rates. Thus, she decided to include departmental data so that the effect of moving to departmental rates could be assessed. Finally, she also wanted to explore the possibility of converting the sawmill and fabric plant into profit centres and changing the existing transfer pricing policy.

With the cooperation of the cost accounting manager for the mill and each plant's controller, she gathered the following data for last year:

Sawmill:

Joint manufacturing costs: $900,000

Grade	Quantity Produced (board feet)	Price at Split-Off (per 1,000 board foot)
Firsts and seconds	1,500,000	$300
No. 1 common	3,000,000	225
No. 2 common	1,875,000	140
No. 3 common	1,125,000	100
Total	7,500,000	

Fabric Plant:

Budgeted overhead: $1,200,000 (50 percent fixed)
Practical volume (direct labour hours): 120,000 hours
Actual overhead: $1,150,000 (50 percent fixed)
Actual hours worked:

	Weaving and Pattern	Colouring and Bolting	Total
Fabric FB60	20,000	12,000	32,000
Fabric FB70	28,000	14,000	42,000
Fabric FB80	26,000	18,000	44,000
Total	74,000	44,000	118,000

Departmental data on Fabric FB70 (actual costs and actual outcomes):

	Weaving and Pattern	Colouring and Bolting
Beginning inventories:		
Units*	20,000	400
Costs:		
Transferred in	$ 0	$100,000
Materials	$80,000	$8,000
Labour	$18,000	$6,600
Overhead	$22,000	$9,000

	Weaving and Pattern	Colouring and Bolting
Current production:		
Units started	80,000	?
Units transferred out	80,000	3,200
Costs:		
Transferred in	$ 0	?
Materials	$320,000	$82,000
Labour	$208,000	$99,400
Overhead	?	?
Percentage completion:		
Beginning inventory	30%	40%
Ending inventory	40%	50%

* Units are measured in metres for the Weaving and Pattern Department and in bolts for the Colouring and Bolting Department. *Note:* With the exception of the cardboard bolt rods, materials are added at the beginning of each process. The cost of the rods is relatively insignificant and is included in overhead.

Proposed standard cost sheet for Fabric FB70 (for the Colouring and Bolting Department only):

Transferred-in materials (25 metres @ $10)	$250.00
Other materials (2.8 metres @ $7.15)	20.00 (rounded)
Labour (3.1 hours @ $8)	24.80
Fixed overhead (3.1 hours @ $5)	15.50
Variable overhead (3.1 hours @ $5)	15.50
Standard cost per unit	$325.80

Furniture Plant:

Departmental data (budgeted):

	Service Departments				Producing Departments	
	Receiving	Power	Maintenance	General Factory	Cutting	Assembly
Overhead	$450,000	$600,000	$300,000	$525,000	$750,000	$375,000
Machine hours	—	—	—	—	60,000	15,000
Receiving orders	—	—	—	—	13,500	9,000
Square metres	1,000	5,000	4,000	—	15,000	10,000
Direct labour hours	—	—	—	—	50,000	200,000

After some discussion with the furniture plant controller, Giselle decided to use machine hours to calculate the overhead rate for the Cutting Department and direct labour hours for the Assembly Department rate (the Cutting Department was more automated than the Assembly Department). As part of her report, she wanted to compare the effects of plantwide rates and departmental rates on the cost of jobs. She wanted to know if overhead costing could be the source of the pricing problems the company was experiencing.

To assess the effect of the different overhead assignment procedures, Giselle decided to examine two prospective jobs. One job, Job A500, could produce 500 sofas, using a frequently requested style and Fabric FB70. Bids on this type of job were being lost more

frequently to competitors. The second job, Job B75, would produce 75 specially designed recliners. This job involved a new design and was more difficult for the workers to build. It involved some special cutting requirements and an unfamiliar assembly. Recently, the company seemed to be winning more bids on jobs of this type. To compute the costs of the two jobs, Giselle assembled the following information on the two jobs:

Job A500:

Direct materials:	
Fabric FB70	180 bolts @ $350
Lumber (No. 1 common)	20,000 board feet @ $0.12
Other components	$26,600
Direct labour:	
Cutting Department	400 hours @ $10
Assembly Department	1,600 hours @ $8.75
Machine time:	
Cutting Department	350 machine hours
Assembly Department	50 machine hours

Job B75:

Direct materials:	
Fabric FB70	26 bolts @ $350
Lumber (first and seconds)	2,200 board feet @ $0.12
Other components	$3,236
Direct labour:	
Cutting Department	70 hours @ $10
Assembly Department	240 hours @ $8.75
Machine time:	
Cutting Department	90 machine hours
Assembly Department	15 machine hours

Required:

1. Allocate the joint manufacturing costs to each grade, and calculate the cost per board foot for each grade: (a) using the physical units method of allocation and (b) using the sales-value-at-split-off method. Which method should the mill use? Explain. What is the effect on the cost of each proposed job if the mill switches to the sales-value-at-split-off method?
2. Calculate the plantwide overhead rate for the fabric plant.
3. Calculate the amount of under- or overapplied overhead for the fabric plant.
4. Using the weighted average method, calculate the cost per bolt for Fabric FB70.
5. Assume that the weaving and pattern process is not a separate process for each fabric. Also, assume that the yarn used for each fabric differs significantly in cost. In this case, would process costing be appropriate for the weaving and pattern process? What costing approach would you recommend? Describe your approach in detail.
6. In the Colouring and Bolting Department, 3,200 tonnes of other materials were used to produce the output of the period. Using the proposed standard cost sheet, calculate the following variances for the Colouring and Bolting Department:
   a. Materials price variance (for other materials only)
   b. Materials usage variance (for other materials only)
   c. Labour rate variance
   d. Labour efficiency variance

   In calculating the variances, which method did you use to compute the actual output of the period—FIFO or weighted average? Explain.

7. Assume that the standard hours allowed for the actual total output of the fabric plant are 115,000. Calculate the following variances:
   a. Fixed overhead spending variance
   b. Fixed overhead volume variance
   c. Variable overhead spending variance
   d. Variable overhead efficiency variance

8. Suppose that the fabric plant has 500 bolts of FB70 in beginning finished goods inventory. The current-year plan is to have 1,000 bolts of FB70 in finished goods inventory at the end of the year. This fabric has an external market price of $400 per bolt. If the fabric plant is set up as a profit centre, it could sell 3,000 bolts per year to outside customers and supply 2,000 bolts per year internally to Beauville's furniture plant. If the fabric plant were designated as a profit centre, the plant would transfer all goods internally at market price. Using the proposed standard cost sheet (as needed) and any other relevant data, prepare the following for Fabric FB70:
   a. Sales budget
   b. Production budget
   c. Direct labour budget
   d. Cost of goods sold budget

9. Calculate the following overhead rates for the furniture plant: (1) plantwide rate and (2) departmental rates. Use the direct method for assigning service costs to producing departments.

10. For each of the overhead rates computed in Requirement 9, calculate unit bid prices for Jobs A500 and B75. Assume that the company's aggressive bidding policy is unit cost plus 50 percent. Did departmental overhead rates have any effect on Beauville's winning or losing bids? What recommendation would you make? Explain. Now, adjust the costs and bids for departmental rate bids using the proposed standard costs for the Colouring and Bolting Department. Did this make a difference? What does this tell you?

11. Suppose that the fabric plant is set up as a profit centre. Bolts of Fabric FB70 sell for $400 (or can be bought for $400 from outside suppliers). The fabric plant and the furniture plant both have excess capacity. Assume that Job A500 is a special order. The fabric and furniture plants have sufficient excess capacity to satisfy the demands of Job A500. What is the minimum transfer price for a bolt of FB70? If the maximum transfer price is $400, by how much do the fabric plant's profits increase if the two profit centres negotiate a transfer price that splits the joint benefit?

Part 3 CONTROL

As part of the management process, managers must implement systems to influence the behaviour of every employee in the organization. These systems are referred to as *controls over the operations*. In most organizations, there should be a clearly defined objective that the company is trying to achieve. When the planning process takes place, the objectives will be clearly defined and every person in the organization will be expected to work to achieve those objectives.

The plans that have been formed early in the management process are compared to the actual performance achieved, and individual managers are evaluated on how well they have met the objectives agreed to during planning. Every company must, therefore, ensure that the tools being used to determine whether the company (or a portion of the company) has met its objectives are fair to everyone.

The comparison of actual results to planned (or budgeted) results will probably have a significant influence on perceptions of the capability of the person being evaluated; this in turn will influence both short-term benefits (salary, bonus, etc.) and long-term benefits (increased responsibility, promotion, a faster career track).

Part 3 of this text illustrates several approaches that companies, and their managers, can take to influence behaviour and evaluate performance. The long-term implications of this process, and the impact it will have on employee behaviour, mean that managers have to be particularly careful to understand the influence that control mechanisms have on the people being evaluated.

After studying this chapter, you should be able to:

- 1 Describe the tactical decision-making model.
- 2 Define the concept of relevant costs and revenues.
- 3 Explain how the activity resource usage model is used in assessing relevancy.
- 4 Apply the tactical decision-making concepts in a variety of business situations.

CHAPTER

11 Tactical Decision Making

A major role of the cost management information system is supplying cost and revenue data that are useful in tactical decision making. This chapter focuses on the use of cost and revenue data in tactical decision making. To make sound decisions, the user of the cost information must be able to decide what is relevant to the decision and what is not relevant.

OBJECTIVE 1
Describe the tactical decision-making model.

Tactical Decision Making

Tactical decision making consists of choosing among alternatives with an immediate or limited end in view. Accepting a special order for less than the normal selling price to use idle capacity and increase this year's profits is an example. The immediate objective is to exploit idle productive capacity so that short-run profits can be increased. Thus, some tactical decisions tend to be *short-run* in nature; however, it should be emphasized that short-run decisions often have long-run consequences. Consider a second example. Suppose that a company is considering producing a

component instead of buying it from suppliers. The immediate objective may be to lower the cost of making the main product. Yet, this tactical decision may be a small part of the overall strategy of establishing a cost leadership position for the firm. Thus, tactical decisions are often *small-scale actions* that serve a larger purpose. Recall that the overall objective of strategic decision making is to establish a long-term competitive advantage. Tactical decision making should support this overall objective, even if the immediate objective is short run (accepting a one-time special order) or small scale (making instead of buying a component). Thus, *sound* tactical decisions achieve not only the limited objective but also serve a larger purpose. In fact, all tactical decisions should serve the overall strategic goals of an organization.

The Tactical Decision-Making Process

A general tactical decision-making model is outlined here. The six steps describing the process are listed below.

1. Recognize and define the problem.
2. Identify alternatives as possible solutions to the problem, and eliminate any unfeasible alternatives.
3. Identify the costs and benefits associated with each feasible alternative. Eliminate the costs and benefits that are not relevant to the decision.
4. Compare the *relevant* costs and benefits for each alternative.
5. Assess qualitative factors.
6. Select the alternative with the greatest overall benefit.

Step 1: Define the Problem To illustrate the steps of the process, consider an apple producer. Each year, 25 percent of the apples harvested are small and odd-shaped. These apples cannot be sold in the normal distribution channels and have simply been dumped in the orchards for fertilizer. The owner is not satisfied with this approach and wants to determine the best way to handle these apples.

Step 2: Identify Feasible Alternatives Several alternatives are being considered:

1. Sell the apples to pig farmers.
2. Bag the apples (two-kilogram bags) and sell them to local supermarkets as seconds.
3. Rent a local canning facility and convert the apples to applesauce.
4. Rent a local canning facility and convert the apples to pie filling.
5. Continue with the current dumping practice.

Of the five alternatives, alternative one was eliminated because there were not enough local pig farmers interested in the apples; alternative five represented the status quo and was eliminated at the request of the owner; alternative four was also eliminated because the local canning facility did not have the equipment needed to produce pie filling. However, the local canning facility's equipment could be used for producing applesauce. Thus, alternative three was possible. Furthermore, since local supermarkets agreed to buy two-kilogram bags of irregular apples and bagging could be done at the warehouse, alternative two was also a possibility. Thus, two alternatives were deemed feasible.

Step 3: Predict Costs and Benefits and Eliminate Irrelevant Costs Suppose that the apple producer predicts that labour and materials (bags and ties) for the bagging option would cost $0.10 per kilogram. The two-kilogram bags of apples could be sold for $1.10 per bag to the local supermarkets. Making applesauce would cost $0.80 per kilogram for facility rental, labour, apples, cans, and other materials. It takes three kilograms of apples to produce five, 500-millilitre cans of applesauce. Each 500-millilitre can will sell for $0.78. The cost of growing and harvesting the apples is not relevant to choosing between the bagging alternative and the applesauce alternative.

Step 4: Compare Relevant Costs and Benefits The bagging alternative costs $0.20 to produce a two-kilogram bag ($0.10 × 2 kilograms), and the revenue is $1.10 per bag, or $0.55 per kilogram. Thus, the net benefit is $0.45 per kilogram ($0.55 − $0.10). For the applesauce alternative, three kilograms of apples produce five 500-millilitre cans of applesauce. The revenue for five cans is $3.90 (5 × $0.78), which converts to $1.30 per kilogram ($3.90/3). Thus, the net benefit is $0.50 per kilogram ($1.30 − $0.80). Of the two alternatives, the applesauce option offers $0.05 more per kilogram than the bagging option.

Step 5: Assess the Qualitative Factors Qualitative factors are those that are very difficult to translate into dollars. For the apple example, the producer currently is not involved in producing any apple consumer products and is reluctant to move into applesauce production. He has no experience in this part of the industrial value chain and knows little about the channels of distribution for applesauce. An outside expert would need to be hired. Additionally, the rental opportunity is a year-to-year issue. In the long term, a major capital commitment might be needed. Bagging the small apples, on the other hand, is a product differentiation strategy that allows the producer to operate within familiar territory.

Step 6: Select the Best Alternative While the applesauce option is somewhat more lucrative, the qualitative factors argue against it. Therefore, the bagging alternative should be chosen. This alternative maintains the current position in the industrial value chain and strengthens the producer's competitive position by following a differentiation strategy for the small, odd-shaped apples.

Summary of Decision-Making Process The six steps define a simple decision model. A **decision model** is a set of procedures that, if followed, will lead to a decision. **Tactical cost analysis** is the use of relevant cost data to identify the alternative that provides the greatest benefit to the organization. Thus, tactical cost analysis includes predicting costs, identifying relevant costs, and comparing relevant costs. As we have seen, however, tactical cost analysis is only part of the overall decision process. Qualitative factors deserve more discussion.

Qualitative Factors

Step five of the decision-making model is critically important. While cost and revenue information is important, other information, often qualitative in nature, is needed to make an informed decision. For example, the relationship of the alternatives being considered to the organization's strategic objectives is essentially a qualitative assessment.

Other qualitative factors are also important. For example, the spike in gasoline prices in 2008–2009 led to renewed interest in hybrid vehicles. While **Toyota**'s Prius, **Nissan**'s Altima, and **Chevrolet**'s two-mode Tahoe SUV had payback periods shorter than five years, the payback on many of these vehicles is quite long. Some take over 10 years to pay back the difference in cost between a hybrid version and nonhybrid version of a vehicle, and a few take close to 100 years![1] Given the fact that the economics are frequently stacked against buying the hybrid version, why do so many people opt for it? Qualitative reasons are often the answer. Individuals like the idea of reducing their carbon footprint and "going green." There is satisfaction in doing something good for the environment. Bradley Berman, editor of Hybridcars.com, mentions the "tech appeal" of the hybrid vehicles. "Hybrids definitely appeal to people who are into 'fun technology,'" he says. "If you were one of the folks who went out and

[1] John O'Dell, "Payback for Many Hybrids Grows as Gas Costs Rise," *Edmunds.com* (June 11, 2008), http://blogs.edmunds.com/greencaradvisor/2008/06/payback-for-many-hybrids-grows-as-gas-costs-rise.html.

got an iPod or iPhone as soon as they came out, and if you use a TiVO instead of a VCR, then you'll probably like the fact that today's hybrids are the most advanced vehicles out there today in terms of electronics."[2]

How should qualitative factors be handled in the decision-making process? First of all, they must be identified. Second, the decision maker should try to quantify them. Often, qualitative factors are simply more difficult to quantify, but not impossible. For example, possible unreliability of an outside supplier might be quantified as the probable number of days late multiplied by the labour cost of downtime in the plant. Finally, truly qualitative factors, such as the impact of late orders on customer relations, or the apple producer's discomfort with the canning option, must be taken into consideration in the final step of the decision-making model—the selection of the alternative with the greatest overall benefit.

Relevant Costs and Revenues

OBJECTIVE 2
Define the concept of relevant costs and revenues.

In choosing between two alternatives, only the costs and revenues relevant to the decision should be considered. Identifying and comparing relevant costs and revenues is the heart of the tactical decision model. **Relevant costs (revenues)** are future costs (revenues) that differ across alternatives. Since relevant revenues are treated in the same way as relevant costs, we will simplify the discussion by concentrating on costs. All decisions relate to the future; accordingly, only future costs can be relevant. In addition, the cost also must differ from one alternative to another. If a future cost is the same for more than one alternative, it has no effect on the decision. Such a cost is an *irrelevant* cost. The ability to identify relevant and irrelevant costs is an important decision-making skill.

Relevant Costs Illustrated

To illustrate the concept of relevant costs, consider Avicom Inc., a company that makes jet engines for commercial aircraft. A supplier has approached the company and offered to sell one component, nacelles (enclosures for jet engines), for what appears to be an attractive price. Avicom faces a make-or-buy decision. Assume that the cost of direct materials used to produce the nacelles is $270,000 per year (based on normal volume). Is this cost relevant? It is certainly a future cost. To produce the component for another year requires that materials be purchased. In addition, it differs across the two alternatives. If the component is purchased from an external supplier, no internal production is needed, and no direct materials need be purchased, reducing the materials cost to zero. Since the cost of direct materials differs across alternatives ($270,000 for the make alternative and $0 for the buy alternative), it is a relevant cost.

Irrelevant Cost Illustrated

Avicom uses machinery to manufacture nacelles. This machinery was purchased five years ago and has an annual depreciation cost of $50,000. Is depreciation a future cost that differs across the two alternatives?

Past Costs Depreciation, in this case, represents an allocation of a cost already incurred. It is a **sunk cost**, because no future decision can alter the original cost of the machinery; the original cost is the same for both alternatives. Although we allocate this sunk cost to future periods and call it *depreciation*, none of the original cost is avoidable. Sunk costs are past costs and are always irrelevant. Thus, the acquisition cost of the machinery and its associated depreciation should not be a factor in the make-or-buy decision.

[2] Kevin Ransom, "Reasons to Buy a Hybrid—or Not," *CNN.com* (January 28, 2008), http://www.cnn.com/2008/LIVING/wayoflife/01/28/buy.hybrid/index.html.

Future Costs Assume that the cost to heat and cool the plant—$40,000 per year—is allocated to different production departments, including the department that produces nacelles, which receives $4,000 of the cost. Is this $4,000 cost relevant to the make-or-buy decision facing Avicom?

The cost of providing plant utilities is a future cost, since it must be paid in future years. But does the cost differ across the make-and-buy alternatives? It is unlikely that the cost of heating and cooling the plant will change whether nacelles are produced or not. Thus, the cost is the same across both alternatives. The amount of the utility payment allocated to the remaining departments may change if production of nacelles is stopped, but the level of the total payment is unaffected by the decision. It is therefore an irrelevant cost.

Relevant Costs and Benefits in International Trade

Relevant costs and benefits are useful in decision making in the international trade arena. For example, a company may import materials for use in production. While this transaction may look identical to the purchase of materials from domestic suppliers, import tariffs add complexity and cost. A **tariff** is a tax on imports levied by the federal government. Any cost associated with the purchase of materials, such as freight-in or a tariff, is a materials cost. Companies search for ways to reduce tariffs. They may restrict the amount of imported materials, alter the materials by adding Canadian resources (to increase the domestic content and gain more favourable tariff status), or utilize foreign trade zones.

Some Canadian companies set up manufacturing plants within **foreign trade zones** (which are physically in Canada but considered to be outside of Canada for tariff purposes). Since tariffs are not paid until the imported materials leave the zone, as part of a finished product, the company can postpone payment of duty and the associated loss of working capital. Additionally, the company does not pay duty on defective materials or inventory that has not yet been included in finished products.

An example may help to illustrate the potential cost advantages. Suppose that Roadrunner Inc. operates a petrochemical plant located in a foreign trade zone. The plant imports volatile materials (i.e., chemicals that experience substantial evaporation loss during processing) for use in production. Wilycoyote Inc. operates an identical plant just outside the foreign trade zone. Consider the impact on duty and related expenditures for the two plants for the purchase of $400,000 of crude oil imported from Venezuela. Both Roadrunner and Wilycoyote use the oil in chemical production. Each purchases the oil about three months before use in production, and the finished chemicals remain in inventory about five months before sale and shipment to the customer. About 30 percent of the oil is lost through evaporation during production. Duty is assessed at 6 percent of cost. Each company faces a 12 percent carrying cost.

Wilycoyote pays duty, at the point of purchase, of $24,000 ($0.06 \times \$400{,}000$). In addition, Wilycoyote has carrying cost associated with the duty payment of 12 percent per year times the portion of the year that the oil is in materials or finished goods inventory. In this case, the months in inventory equal 8 ($3 + 5$). Total duty-related carrying cost is $1,920 ($0.12 \times 8/12 \times \$24{,}000$). Together, duty and duty-related carrying cost totals $25,920. Roadrunner, on the other hand, pays duty at the time of sale because it is in a foreign trade zone. Imported goods do not incur duty until (unless) they are moved out of the zone. Since 70 percent of the original imported oil remains in the final product, duty equals $16,800 ($0.7 \times \$400{,}000 \times 0.06$). There is no carrying cost associated with the duty. The duty-related costs for the two companies are summarized below.

	Roadrunner	Wilycoyote
Duty paid at purchase	$ 0	$24,000
Carrying cost of duty	0	1,920
Duty paid at sale	16,800	0
Total duty and duty-related cost	$16,800	$25,920

Clearly, Roadrunner's foreign trade zone location has saved $9,120 ($25,920 – $16,800) on just one purchase of imported materials.

In the above example, the underlying business decision involves whether or not to locate in a foreign trade zone. Relevant costs include the cost of duty and the carrying cost of duty for plants located inside and outside the zone. Additional potential for cost reduction inside the zone occurs when goods that do not meet Canadian health, safety, and pollution control regulations are subject to fine. Noncomplying foreign goods can be imported into foreign trade zones and modified to comply with the law without being subject to the fine. Another example of the efficient use of foreign trade zones is the assembly of high-tariff component parts into a lower-tariff finished product. In this case, the addition of domestic labour raises the domestic content of the finished product and makes the embedded foreign parts eligible for more favourable tariff treatment.[3] A qualitative factor is that logistics may be streamlined by using foreign trade zones, leading to quicker and more efficient clearance of customs.

The Activity Resource Usage Model

OBJECTIVE 3
Explain how the activity resource usage model is used in assessing relevancy.

Understanding cost behaviour is basic in determining relevancy. When costs were primarily unit-based, a simple distinction between fixed and variable costs could be made. Now, however, the ABC model has us focus on unit-level, batch-level, product-level, and facility-level costs. The first three are variable, but with respect to different types of activity drivers. The activity resource usage model can help us sort out the behaviour of various activity costs and assess their relevance.

The **activity resource usage model** focuses on the use of resources and has two categories: (1) flexible resources and (2) committed resources. Recall from Chapter 2 that flexible resources are those that are acquired as used and needed. Committed resources are acquired in advance of usage. These categories and their usefulness in relevant costing are described in the following sections.

Flexible Resources

Resource spending is the cost of acquiring activity capacity. The amount paid for the supply of an activity is the activity cost. For flexible resources, the resources demanded (used) equal the resources supplied. Thus, for this category, *if the demand for an activity changes across alternatives*, then resource spending will change and the cost of the activity is relevant to the decision. For example, electricity supplied internally uses fuel for the generator. Fuel is a flexible resource. Consider the following two alternatives: (1) accept a special, one-time order and (2) reject the special order. If accepting the order increases the demand for kilowatt-hours (power's activity driver), then the cost of power will differ across alternatives by the increase in fuel consumption. Thus, power cost is relevant to the decision.

Committed Resources

Committed resources are acquired in advance of usage through implicit contracting, and they are usually acquired in lumpy amounts. Consider an organization's employees. The implicit understanding may be that the organization will maintain employment levels even though there may be temporary downturns in the amount of an activity used, meaning that an activity may have unused capacity. Increased demand for an activity across alternatives may not mean increased cost—if there is sufficient unused capacity. For example, assume a company has five manufacturing engineers who can each work 2,000 hours and earn $50,000 per year; total engineering

[3] These examples are taken and adapted from James E. Groff and John P. McCray, "Foreign-Trade Zones: Opportunity for Strategic Development in the Southwest," *Journal of Business Strategies* (Spring 1992): 14–26.

capacity is 10,000 (5 × 2,000 hours) engineering hours. Suppose that this year the company expects to use only 9,000 engineering hours for its normal business. This means that the engineering activity has 1,000 hours of unused capacity. If there is a special order that requires 500 engineering hours, the cost of engineering would be irrelevant. The order can be filled using unused engineering capacity, and the resource spending is the same for each alternative ($250,000 will be spent whether or not the order is accepted).

However, *if a change in demand for the activity requires a change in resource supply*, then the activity cost will be relevant to the decision. This change in cost can occur in one of two ways: (1) the demand for the resource exceeds the supply (increases resource spending) or (2) the demand for the resource drops permanently and supply exceeds demand enough so that activity capacity can be reduced (decreases resource spending).

To illustrate the first change, suppose that the special order requires 1,500 engineering hours. This exceeds the unused capacity of 1,000 hours. To meet the demand, the organization would need to hire a sixth engineer or perhaps use a consulting engineer. Either way, spending on engineering increases if the order is accepted; the cost of engineering is now a relevant cost.

To illustrate the second type of change, suppose that the company could purchase a component used for production instead of making it in house. Recall that 10,000 engineering hours are available and that 9,000 are used. If the component is purchased, then the demand for engineering hours will drop from 9,000 to 7,000. This is a permanent reduction because engineering support will no longer be needed for manufacturing the component. Because unused capacity is now 3,000 hours, and engineering capacity is acquired in chunks of 2,000 hours, the company can reduce capacity and resource spending by laying off one engineer or reassigning the engineer to another plant where the services are in demand. Either way, the resource supply is reduced to 8,000 hours. Engineering cost would differ by $50,000 (the salary for one engineer) across the make-or-buy alternatives. This cost is then relevant to the decision.

Often, committed resources are acquired in advance for multiple periods—before resource demands are known. Leasing or buying a building is an example. Buying multiperiod activity capacity is often done by paying cash up front. In this case, an annual expense may be recognized, but no additional resource spending is needed. Up-front resource spending is a sunk cost and never relevant. Periodic resource spending, such as leasing, is essentially independent of resource usage. Even if a permanent reduction of activity usage is experienced, it is difficult to reduce resource spending because of formal contractual commitments.

For example, assume a company leases a plant for $100,000 per year for 10 years. The plant is capable of producing 20,000 units of a product—the level expected when the plant was leased. After five years, the demand for the product drops and the plant needs to produce only 15,000 units each year. The annual lease payment of $100,000 must still be paid even though units produced have decreased. Suppose instead that demand increases beyond the 20,000-unit capability. The company may consider buying or leasing an additional plant. Here, resource spending could change across alternatives. Exhibit 11-1 summarizes the activity resource usage model's role in assessing relevancy.

OBJECTIVE 4

Apply the tactical decision-making concepts in a variety of business situations.

Illustrative Examples of Tactical Decision Making

The activity resource usage model and the concept of relevancy are valuable tools in making tactical decisions. It is important to see how they are used to solve a variety of problems. Applications include decisions to make or buy a component, to keep or drop a segment or product line, to accept or reject a special order at less than the usual price, and to process a joint product further or sell it at the split-off point. Of course, this is not an exhaustive list. The same decision-making principles can be applied to other settings. Once you see how they are used, it is relatively easy to apply them in any appropriate setting. In illustrating the applications, we assume that the

Exhibit 11-1

Resource Demand and Supply

Category	Relationships	Relevancy
Flexible	Supply = Demand	
	a. Demand changes	a. Relevant
	b. Demand constant	b. Not relevant
Committed	Supply − Demand = Unused capacity	
	a. Demand increase < Unused capacity	a. Not relevant
	b. Demand increase > Unused capacity	b. Relevant
	c. Demand decrease (permanent)	
	1. Activity capacity reduced	1. Relevant
	2. Activity capacity unchanged	2. Not relevant

first two steps of the tactical decision-making model have already been done. Thus, the emphasis is on tactical cost analysis.

Make-or-Buy Decisions

Organizations are often faced with a **make-or-buy decision**—a decision of whether to make or to buy components or services used in making a product or providing a service. For example, a physician can buy laboratory tests from external suppliers (hospitals or for-profit laboratories), or these lab tests can be done internally. Similarly, a PC computer manufacturer can make its own disk drives, or they can be bought from external suppliers.

Outsourcing of technical and professional jobs is becoming an important make-or-buy issue. **Outsourcing** refers to the move of a business function to another company, either inside or outside Canada.

For example, some newspapers are closing down their foreign news bureaus and outsourcing the jobs to other companies.[4] CAs find that income tax preparation can be outsourced to lower-cost providers in India.[5]

Qualitative considerations are important in the outsourcing decision. Time is a valuable resource, and many companies have found that a global presence leads to time and quality enhancement. For example, software companies have found that call centres located in Ireland and the United States provide better customer service. At 8 a.m., a customer in Toronto who needs an answer to a question may not get help from a California-based call centre, but will get help from a Dublin-based centre. On the negative side, the political ramifications of outsourcing, with its overtones of "exporting jobs," have led companies to weigh the decision more carefully.

Make-or-buy decisions are not short run in nature but fall into the small-scale tactical decision category. For example, the decision to make or buy may be motivated by cost leadership and/or differentiation strategies. Making instead of buying (or vice versa) may be one way to reduce the cost of producing the main product. Alternatively, choosing to make or buy may be a way of increasing the quality of the component and thus increasing the overall quality of the final product (differentiating on the basis of quality). Cornerstone 11-1 shows the how and why of structuring the make-or-buy decision.

Cost Analysis: Activity-Based Cost Management System The make-or-buy problem can also be illustrated in an activity-based costing format. The

[4] Russell Adams and Shira Ovide, "Newspapers Move to Outsource Foreign Coverage," *The Wall Street Journal* (January 15, 2009): B4.

[5] Gary S. Shamis, M. Cathryn Green, Susan M. Sorensen, and Donald L. Kyle, "Outsourcing, Offshoring, Nearshoring: What to Do?" *Journal of Accountancy* (June 2005), http://www.journalofaccountancy.com/Issues/2005/Jun/OutsourcingOffshoringNearshoringWhatToDo.htm.

CORNERSTONE 11-1

The HOW and WHY of Structuring a Make-or-Buy Decision

Information:

Ling Company produces 100,000 units of Part 34B, used in one of its snow-blower engines, each year. An outside supplier has offered to supply the part for $4.75. The unit cost is:

Direct materials	$0.50
Direct labour	2.40
Variable overhead (power)	0.90
Fixed overhead	1.05
Total unit cost	$4.85

Overhead is applied on the basis of machine hours; Part 34B requires 30,000 machine hours per year.

Why:

The make-or-buy situation requires the company to focus on relevant costs and benefits. The problem is set up with relevant costs and benefits organized under column headings for each alternative. The difference between the alternatives gives the quantitative advantage/disadvantage for each alternative.

Required:

1. What are the alternatives for Ling Company?
2. Assume that none of the fixed cost is avoidable. List the relevant cost(s) of internal production and of external purchase.
3. Which alternative is more cost effective and by how much?
4. ***What if*** $60,000 of fixed overhead is supervision for Part 34B that is avoided if the part is purchased? Which alternative is more cost effective and by how much?

Solution:

1. The alternatives are to make the part in house or buy the part externally.
2. The relevant costs of making the part are direct materials, direct labour, and variable factory overhead. The relevant cost of buying the part is the purchase price.
3.

	Make	Buy	Difference
Direct materials	$ 50,000	$ 0	$ 50,000
Direct labour	240,000	0	240,000
Variable overhead	90,000	0	90,000
Purchase price	0	475,000	(475,000)
Totals	$380,000	$475,000	$ (95,000)

Because the fixed overhead is not relevant, the analysis shows a $95,000 advantage in favour of making the part in house.

4.

	Make	Buy	Difference
Direct materials	$ 50,000	$ 0	$ 50,000
Direct labour	240,000	0	240,000
Variable overhead	90,000	0	90,000
Supervision	60,000	0	60,000
Purchase price	0	475,000	(475,000)
Totals	$440,000	$475,000	$ (35,000)

Now, supervision (part of fixed overhead) is relevant; the analysis shows a $35,000 advantage in favour of making the part in house.

Exhibit 11-2

Activity and Cost Information

Activity		Activity Cost Formula: Fixed Cost		Variable Rate		Amount of Driver
Providing power	=	$0	+	$3	×	Machine hours
Providing supervision	=	$0	+	$20,000	×	Lines
Moving materials	=	$250,000	+	$0.60	×	Number of moves
Inspecting product	=	$280,000	+	$1.50	×	Inspection hours
Setting up equipment	=	$0	+	$10	×	Setup hours
Providing space	=	$971,000				Square metres
Depreciation	=	$120,000				Units

Activity Driver	Total Capacity	Expected Usage	Part 34B Usage	Units of Purchase
Machine hours	As needed	750,000	30,000	1
Supervisory lines	15	15	3	3
Moves	250,000	240,000	40,000	25,000
Inspection hours	16,000	14,000	2,000	2,000
Setup hours	60,000	58,000	6,000	2,000
Providing space	971,000	971,000	5,000	50,000
Depreciation	620,000	100,000	100,000	15,000

structure of the problem is the same as that shown in Cornerstone 11-1; however, typically the relevant costs are more extensive and care must be taken to determine which activities are relevant, and by how much. To illustrate the ABC analysis for Ling Company's Part 34B, we will use the data in Exhibit 11-2 along with the data from Cornerstone 11-1. All activity capacities are annual capacity measures. The cost of providing space includes annual plant depreciation, property taxes, and annual maintenance. This cost is allocated to the products based on the square metres of space occupied by the product's production equipment. The variable component of each activity represents the cost of flexible resources. The fixed cost component represents the cost of committed resources acquired in advance of usage. Units of purchase indicate how many units of the activity (as measured by its driver) must be acquired at a time. For example, if more capacity for moving materials is needed, it must be bought in lump sums of 25,000 moves at a time.

To determine whether Ling should continue to make Part 34B or buy it from an external supplier depends on how much *resource spending* can be reduced because of the ability to reduce resource usage (by buying instead of making). As is done in Cornerstone 11-1, the problem is structured as follows:

	Make	Buy	Difference
Direct materials	$ 50,000	$ 0	$ 50,000
Direct labour	240,000	0	240,000
Providing power	90,000	0	90,000
Providing supervision	60,000	0	60,000
Moving materials	49,000	0	49,000
Inspecting product	38,000	0	38,000
Setting up equipment	60,000	0	60,000
Purchase price	0	475,000	(475,000)
Totals	$587,000	$475,000	$ 112,000

If Ling buys Part 34B instead of making it, *resource usage* decreases for each of the seven activities. Let's review them.

Direct materials, direct labour, and power are strictly variable and their amounts are identical to those calculated in Cornerstone 11-1.

$$\text{Direct materials} = \$0.50 \times 100{,}000 \text{ units} = \$50{,}000$$
$$\text{Direct labour} = \$2.40 \times 100{,}000 \text{ units} = \$240{,}000$$
$$\text{Power} = \$3.00 \times 30{,}000 \text{ units} = \$90{,}000$$

Supervision is a lumpy resource and must be acquired in units of three lines. Since the making of Part 34B requires exactly three lines, the amount of supervision needed is \$60,000 (\$20,000 × 3 lines).

Moving materials and inspecting product are a bit more complicated since there is a variable and a fixed amount.

$$\begin{aligned}\text{Moving materials} &= (\$250{,}000/250{,}000 \text{ moves at capacity})(25{,}000) \\ &\quad + (\$0.60 \times 40{,}000 \text{ moves}) \\ &= \$49{,}000 \\ \text{Inspecting product} &= (\$280{,}000/16{,}000 \text{ inspection hours at capacity})(2{,}000) \\ &\quad + (\$1.50 \times 2{,}000 \text{ inspection hours}) \\ &= \$38{,}000\end{aligned}$$

Notice that the fixed amount associated with Part 34B is the amount by which fixed resource spending can be reduced, so it depends on the total capacity—250,000 moves for moving materials and 16,000 inspection hours for inspecting product. The fixed rate is multiplied by the lumpy amount or the units that must be purchased at once. The variable amount of resource spending associated with Part 34B is the amount of driver actually used in producing the part times the variable rate.

Setting up equipment is strictly variable with respect to the number of setup hours. Since Part 34B uses 6,000 setup hours, and the rate is \$10 per setup hour, the production of the part requires \$60,000.

Notice that providing space and equipment depreciation are ignored since they are irrelevant costs. They will remain the same in total no matter whether the part is made internally or purchased externally.

As we can see, the additional information provided by activity-based costing changed the analysis so that purchasing the part is better. The company will save \$112,000 per year if the part is bought externally. Of course, this is just the quantitative analysis. There may be compelling qualitative factors that Ling should consider. For example, will the outside supplier maintain the quality needed by Ling? Will the supplier be able to meet delivery requirements? Only a full analysis that considers both quantitative and qualitative factors will give management the support to make a good decision.

Keep-or-Drop Decisions

Often, a manager needs to determine whether a segment, such as a product line, should be kept or dropped. **General Motors**, for example, decided to drop a number of car lines, including Oldsmobile, Hummer, Saab, and Saturn.[6] A **keep-or-drop decision** uses relevant cost analysis to determine whether a segment or line of business should be kept or dropped. In a traditional cost management system, segmented income statements, using unit-based fixed or variable costs, improve the ability to make keep-or-drop decisions. Cornerstone 11-2 shows the how and why of structuring the keep-or-drop decision analysis.

As Cornerstone 11-2 shows, revenues and costs that are directly attributable to a segment must be identified. If the segment is dropped, then only the traceable revenues and costs should vanish. Furthermore, the traceable income (loss) determines whether a segment should be dropped or kept. If the product (or segment) margin is

[6] Todd Lassa, "GM's Survival Strategy: Divisions, Nameplates to Disappear," *Motor Trend* (March 23, 2009), http://www.motortrend.com/features/auto_news/2009/112_0903_gm_survival_strategy/index.html.

The HOW and WHY of Structuring a Keep-or-Drop Product Line Decision

CORNERSTONE 11-2

Information:

Dexter Company makes three types of GPS devices. The Basic GPS model is an entry-level automotive GPS device; it is sold through discounters and Amazon.com. The Runner's GPS is a miniaturized model that allows the runner to track mileage, steps, and heart rate while running; it is sold through athletic stores and on sports gear websites. The Chart Plotter is a specialized GPS device for sailors; it can be customized with maps of the sea floor and specific geographic areas of coast line and deep water. It is sold via the Web on dedicated GPS sites. Dexter Company is considering dropping the Basic GPS line and keeping the Runner's GPS and Chart Plotter. The segmented income statement is presented on the following page.

	Basic GPS	Runner's GPS	Chart Plotter	Total
Sales	$ 450,000	$ 980,000	$1,670,000	$ 3,100,000
Less variable costs	(324,000)	(372,000)	(601,600)	(1,297,600)
Contribution margin	126,000	608,000	1,068,400	1,802,400
Less direct fixed costs:				
Advertising	(85,000)	(124,000)	(130,000)	(339,000)
Supervision	(60,000)	(115,000)	(135,000)	(310,000)
Product margin	$ (19,000)	$ 369,000	$ 803,400	1,153,400
Less common fixed expenses				915,000
Operating income				$ 238,400

Why:

Companies need to consider whether a segment or product line should remain. This problem requires a look at the relevant costs and benefits of dropping the segment.

Required:

1. List the alternatives being considered.
2. List the relevant benefits and costs for each alternative.
3. Which alternative is more cost effective and by how much?
4. ***What if*** dropping the Basic GPS line would mean a 10 percent loss of volume for the Runner's GPS device and a 2 percent loss in volume for the Chart Plotter? Which alternative would be more cost effective and by how much?

Solution:

1. The two alternatives are to keep the Basic GPS line or to drop it.
2. The relevant benefits and costs of keeping the Basic GPS line include sales of $450,000, variable costs of $324,000, advertising cost of $85,000, and supervision cost of $60,000. All common fixed costs are irrelevant. None of the relevant benefits and costs of keeping the Basic GPS line would occur under the drop alternative.

CORNERSTONE 11-2 *(continued)*

3.

	Keep	Drop	Differential Amount to Keep
Sales	$450,000	$0	$ 450,000
Less variable costs	324,000	0	(324,000)
Contribution margin	126,000	0	126,000
Less direct fixed costs:			
Advertising	(85,000)	0	(85,000)
Supervision	(60,000)	0	(60,000)
Product margin	$ (19,000)	0	$ (19,000)

There is a $19,000 loss if the Basic GPS line is kept.

4.

	Basic GPS	Runner's GPS	Chart Plotter	Total
Sales	$0	$ 882,000	$1,636,600	$2,518,600
Less variable costs	0	(334,800)	(589,568)	(924,368)
Contribution margin	0	547,200	1,047,032	1,594,232
Less direct fixed costs:				
Advertising	0	(124,000)	(130,000)	(254,000)
Supervision	0	(115,000)	(135,000)	(250,000)
Product margin	$0	$ 308,200	$ 782,032	1,090,232
Less common fixed expenses				915,000
Operating income				$ 175,232

Difference in income = Income with all three lines − Income with only two lines
= $238,400 − $175,232 = $63,168

Because of the impact that dropping the Basic GPS line has on the sales of the other two lines, the analysis shows that dropping the line will actually decrease income by $63,168. Therefore, the Basic GPS line should be kept. However, it would be a good idea to consider ways to make production more efficient.

positive, then the segment is kept; if negative, then the segment may be dropped. Cornerstone 11-2 shows a traditional segmented income statement, where products are defined as segments. The statement indicates that both Runner's GPS and Chart Plotter models provide positive product margins and the Basic GPS model has a negative product margin. Thus, management would likely consider dropping the Basic GPS model. However, when the analysis considers potential complementary effects—the impact of the dropped product line on sales of the other two product lines—the decision likely would change. In the latter case, it is clear that customers prefer a full line of products, and that the Basic GPS somehow adds to the profitability of the other two GPS models.

A company can improve the differential analysis by looking beyond the traditional product costing model. That is, managers can consider more than the unit-based variable versus fixed cost categories by looking at the impact of non-unit costs.

For example, convenience stores constantly balance the need to offer a wide selection of products with the need to streamline offerings so that they can fit into the small-store format. In the past, the stores determined which products to stock based on each one's profitability. Profit was calculated as the difference between wholesale and retail prices. While this sounds reasonable, it completely ignores the additional costs associated with carrying and stocking each product line. In early 2001, the **American Wholesale Marketers Association** and the **National Association of Convenience Stores** presented the results of a study of new software designed to "assess each item's profitability by factoring in the operating, labour, inventory, and overhead costs of each item." In the past, the cost of handling a product was not considered when determining per-product costs. However, handling costs are a significant part of the total cost structure.

One owner of a chain of convenience stores tested the software and learned that every auto fuse and bulb sold resulted in a loss of 50 cents. He surveyed customers and found that they were willing to pay a higher price. As a result, he raised the price by $1. This achieved two goals. The bulbs and fuses now make money, and customers still appreciate the opportunity to pop into the convenience store for suddenly needed products. The same chain determined that three kinds of laundry detergent were two too many. It pared its offering to one brand and displayed it more prominently. Sales increased by 20 percent, while costs fell because the sole brand could be ordered by the case.[7]

Let's continue the Dexter Company example using activity data. Suppose that Dexter Company finds that the common fixed expenses actually include some traceable fixed expenses that can be assigned to the product lines based on non-unit driver usage. In particular, three such expenses and their activity data are shown in the following table:

Activity	Driver	Total Capacity	Unused Capacity	Basic GPS Usage	Units of Purchase
Inspecting products	Number of batches	200	15	80	40
Customer service	Number of calls	30,000	900	12,000	1,000
Material handling	Number of moves	2,800	400	1,400	350

Now we can reanalyze the keep-or-drop decision with the additional activity information.

	Keep	Drop	Differential Amount to Keep
Sales	$ 450,000	$0	$ 450,000
Less variable costs	324,000	0	(324,000)
Contribution margin	126,000	0	126,000
Less direct fixed costs:			
Advertising	(85,000)	0	(85,000)
Supervision	(60,000)	0	(60,000)
Inspection[a]	(56,000)	0	(56,000)
Customer service[b]	(60,000)	0	(60,000)
Material handling[c]	(70,000)	0	(70,000)
Product margin	$(205,000)	0	$(205,000)

[a] Inspection rate = $140,000/200 = $700; $700 × 80 batches = $56,000
[b] Customer service rate = $150,000/30,000 = $5; $5 × 12,000 calls = $60,000
[c] Material handing rate = $140,000/2,800 = $50; $50 × 1,400 moves = $70,000

[7] Ann Zimmerman, "Convenience Stores Create Software to Boost Profitability and Cut Costs," *The Wall Street Journal Interactive Edition* (February 15, 2001).

Notice that the amount of each traceable fixed activity used by the Basic GPS can be eliminated. There is a $205,000 loss if the Basic GPS line is kept. While the use of ABC does not change the structure or conceptual basis of the keep-or-drop decision, it does give managers a better idea of just which costs will be affected by the analysis.

As always, qualitative factors are considered in the keep-or-drop decision. If a line is being dropped, how will it affect customer loyalty? Will employees need to be laid off, or can the excess labour be absorbed into other lines? Some of these factors can be quantified, or probabilities can be assigned so that managers can use sensitivity analysis. Others are truly qualitative and must be considered subjectively.

Special-Order Decisions

In general, price discrimination laws require that firms engaged in interprovincial commerce sell identical products at the same price to competing customers in the same market. These restrictions do not apply to competitive bids or to noncompeting customers. Bid prices can vary to customers in the same market, and firms often have the opportunity to consider one-time special orders from potential customers in markets not ordinarily served. A **special-order decision** focuses on whether a specially priced order should be accepted or rejected. Special-order decisions are examples of tactical decisions with a short-term focus. Increasing short-term profits is the limited objective represented by this type of decision. Care should be taken so that acceptance of special orders does not jeopardize normal distribution channels or adversely affect other strategic elements. With this qualification, it should be noted that special orders often can be attractive, especially when the firm has unused capacity. For this situation, the company can focus its analysis on resources acquired as needed—because this will be the source of any increase in resource spending attributable to the order.

Suppose, for example, that Polarcreme Inc., an ice-cream company, is operating at 80 percent of its productive capacity, 10 million litre units. An ice-cream distributor from a geographic region not normally served by the company has offered to buy 2 million units of premium ice cream at $1.75 per unit, provided its own label can be attached to the product. Normal selling price is $2.50 per unit. Cornerstone 11-3 shows how and why the special-order decision should be structured.

Notice that the special order in Cornerstone 11-3 has a price of $1.75 per unit, well below the normal selling price of $2.50; in fact, it is even below the total unit cost. Even so, accepting the order was profitable for the company. The company has sufficient idle capacity, and the order will not displace other units being produced to sell at the normal price. Additionally, some of the costs are not relevant, such as the commissions, distribution, and fixed cost. The added cost attributable to the special order is, of course, included in the analysis. Requirement 4 of Cornerstone 11-3 asks us to consider the potential impact of the special order on existing customers. In this case, it was easy to quantify the impact and see that the special order should be rejected. In other cases, managers may have to consider the impact on other customers as part of the qualitative factors impinging on the order.

Decisions to Sell or Process Further

As discussed in Chapter 7, joint products have common processes and costs of production up to a split-off point. At that point, they become distinguishable. For example, certain minerals such as copper and gold may both be found in a given ore. The ore must be mined, crushed, and treated before the copper and gold are separated. The point of separation is called the split-off point. The costs of mining, crushing, and treatment are common to both products.

Often, joint products are sold at the split-off point. But sometimes it is more profitable to process a joint product further, beyond the split-off point, prior to selling it. Determining whether to **sell or process further** is an important decision that a manager must make. The key point in this decision is that all of the joint

The HOW and WHY of Structuring a Special-Order Decision

CORNERSTONE 11-3

Information:

Polarcreme Inc., an ice-cream company, is operating at 80 percent of its productive capacity, 10 million litre units. An ice-cream distributor from a different geographic region has offered to buy 2 million units of premium ice cream at $1.75 per unit, provided its own label can be attached to the product. Normal selling price is $2.50 per unit. Cost information for the premium ice cream follows:

	Total of 8,000,000 Units	Unit Cost
Variable costs:		
Direct materials	$ 7,600,000	$0.95
Direct labour	2,000,000	0.25
Packaging	1,600,000	0.20
Commissions	160,000	0.02
Distribution	240,000	0.03
Other variable costs	400,000	0.05
Non-unit-level costs:		
Purchasing ($8 × 40,000 purchase orders)	320,000	0.04
Receiving ($6 × 80,000 receiving orders)	480,000	0.06
Setting up ($8,000 × 50 setups)	400,000	0.05
Fixed costs	1,600,000	0.20
Total costs	$14,800,000	$1.85

The special order will not require commissions or distribution (the buyer will pick up the order at Polarcreme's factory). The order will require 10,000 purchase orders, 20,000 receiving orders, and 13 setups. In addition, a one-time cost for the special order's label template will be required at $24,500.

Why:

A special order is "special" because the price is lower than normal. Companies need to consider all relevant costs and benefits when considering a special order.

Required:

1. List the alternatives being considered.
2. List the relevant benefits and costs for each alternative.
3. Which alternative is more cost effective and by how much?
4. ***What if*** accepting the special order upset a regular customer who was considering expanding into the new geographical region and decided, then, to take their regular annual order of 2 million units of premium ice cream to another company? Which alternative would be better?

Solution:

1. The two alternatives are to accept or reject the special order.
2. The relevant benefits and costs of accepting the order include revenue, direct materials, direct labour, packaging, other variable costs, purchasing, receiving, setting up, and the cost of the label template. No fixed costs will be affected. If the order is rejected, the net benefit is zero.

CORNERSTONE 11-3 *(continued)*

3.

	Accept	Reject	Differential Amount to Accept
Sales	$ 3,500,000	$0	$ 3,500,000
Direct materials	(1,900,000)	0	(1,900,000)
Direct labour	(500,000)	0	(500,000)
Packaging	(400,000)	0	(400,000)
Other variable costs	(100,000)	0	(100,000)
Purchasing ($8 × 10,000 purchase orders)	(80,000)	0	(80,000)
Receiving ($6 × 20,000 receiving orders)	(120,000)	0	(120,000)
Setting up ($8,000 × 13 setups)	(104,000)	0	(104,000)
Label template	(24,500)	0	(24,500)
Net benefit	$ 271,500	0	$ 271,500

There is a $271,500 increase in operating income if the special order is accepted.

4. In this case, the regular order, at $2.50 per unit, would be better than the special order at $1.75 per unit and the company would be better off rejecting the special order. Even though the special order avoids the commission and distribution charge, those total only $0.05 per unit, and the company would be better off making the additional $0.75 in price with the regular customer, not to mention avoiding the $24,500 for the special label template.

production costs are irrelevant to the sell or process further decision. By the time the split-off point is reached, all joint costs are sunk and therefore irrelevant.

To illustrate, consider Lafleur Corporation. Lafleur is an agricultural corporation that produces and sells fresh produce and canned food products. The Leamington Division of Lafleur specializes in tomato products. Leamington has a large tomato farm that produces all the tomatoes used in its products. The farm is divided into manageable plots. Each plot produces approximately 1,500 kilograms of tomatoes; this defines a load. Each plot must be cultivated, fertilized, sprayed, watered, and harvested. When the tomatoes have ripened, they are harvested. The tomatoes are then transported to a warehouse, where they are washed and sorted. The approximate cost of all these activities is $200 per load.

Tomatoes are sorted into two grades (A and B). Grade A tomatoes are larger and better shaped than Grade B. Grade A tomatoes are sold to large supermarkets. Grade B tomatoes are sent to the canning plant, where they are processed into catsup, tomato sauce, and tomato paste. Each load produces about 1,000 kilograms of Grade A tomatoes and 500 kilograms of Grade B tomatoes. Recently, the manager of the canning plant requested that the Grade A tomatoes be used for a Lafleur hot sauce. Studies have indicated that the Grade A tomatoes provided a better flavour and consistency for the sauce than did Grade B tomatoes. Furthermore, Grade B tomatoes are fully utilized for other products. Cornerstone 11-4 shows the how and why of structuring a sell at split-off or process further decision.

Cornerstone 11-4 shows that the joint cost of production, the $200 per load to grow and harvest the tomatoes, is irrelevant and can be ignored. It should be reiterated that the allocation of joint cost to the various joint products is done solely for the purposes of costing product and valuing inventories. It is not a part of the sell or process further decision. There is one other situation in which the joint cost is

The HOW and WHY of Structuring a Sell at Split-Off or Process Further Decision

CORNERSTONE 11-4

Information:

Lafleur Company grows and sells fresh and canned food products. The Leamington farm grows and harvests tomatoes. Each plot yields 1,500 kilograms of tomatoes, referred to as a load; of the 1,500 kilograms, 1,000 kilograms are Grade A tomatoes and 500 are Grade B. The cost of growing and harvesting the tomatoes is $200 per load. Lafleur can sell the 1,000 kilograms of Grade A tomatoes in a load to grocers for $0.40 per kilogram. Alternatively, the tomatoes could be processed into hot sauce. Each bottle of hot sauce sells for $1.50 and requires one kilogram of tomatoes. The cost of additional processing averages $1 per bottle; this amount includes the remaining ingredients, bottles, labour, and needed processing activities.

Why:

Because joint costs are incurred prior to the split-off point, they are sunk costs in determining whether to sell a product at split off or process it further. Only the sales value at split-off, the further processing costs, and the eventual sales value are relevant to this decision.

Required:

1. List the alternatives being considered.
2. List the relevant benefits and costs for each alternative.
3. Which alternative is more cost effective and by how much?
4. ***What if*** the best of the Grade A tomatoes, Premium A's, could be sold to grocers for $0.80 per kilogram? Of the 1,000 kilograms of Grade A tomatoes in a load, about 30 percent are Premium A's. However, the grocers will not buy the Premium A's unless they are also sold the regular Grade A tomatoes. (They will deal with another supplier instead.) It will cost an additional $50 per load to separate the Premium A's from the regular Grade A's. Which alternative would be better?

Solution:

1. The two alternatives are to sell the Grade A tomatoes at split-off or process them further.
2. The relevant benefits and costs of selling at split-off versus processing the tomatoes further include revenue from sale to grocers and revenue from selling the hot sauce less the additional (further) processing costs. The $200 per load cost of growing and harvesting the tomatoes is sunk and need not be considered.
3.

	Sell at Split-Off	Process Further	Differential Amount to Process Further
Sales	$400	$ 1,500	$ 1,100
Further processing cost	0	(1,000)	(1,000)
Total	$400	$ 500	$ 100

   There is a $100 per load advantage to processing the Grade A tomatoes into hot sauce.
4. In this case, 300 kilograms of the Grade A tomatoes (Premium A's) are sold for $0.80 and the remaining 700 kilograms are sold for $0.40. The total revenue at split-off would be $520 ($240 + $280). (You might think that the original alternative still exists—sell all of the Grade A tomatoes at

CORNERSTONE 11-4 *(continued)*

split-off for $0.40 per kilogram. While that alternative does exist, it is so clearly dominated by the new alternative with the higher-priced Premium A's that it can be safely ignored. The firm will no longer consider it.)

	Sell at Split-Off	Process Further	Differential Amount to Process Further
Sales	$520	$ 1,500	$ 980
Further processing cost	(50)	(1,000)	(950)
Total	$470	$ 500	$ 30

There is a $30 per load advantage to processing the Grade A tomatoes into hot sauce.

considered, and that would be the management decision to engage in the joint production process at all. If the total revenues do not cover all costs (both joint and further processing), then the company may want to reconsider being in that line of business.

Relevant Costing and Ethical Behaviour

ETHICS Relevant costs are used in making tactical decisions—decisions that have an immediate view or limited objective in mind. In making these decisions, however, decision makers should always keep the decisions within an ethical framework. Reaching objectives is important, but how you get there is perhaps even more important. Unfortunately, many managers have the opposite view. Part of the reason for the problem is the extreme pressure to perform that many managers feel. Often, the individual who is not a top performer may be laid off or demoted. Under such conditions, the temptation is often great to engage in questionable behaviour.◆

For example, the price of cashmere decreased greatly during the 1990s. The lower price of cashmere fibre meant that sweaters and coats became much more affordable, and imports from China and Hong Kong more than doubled. Unfortunately, the cashmere content of the clothing was uneven, and, on occasion, misrepresented to the eventual seller. In the fall of 2000, **Lands' End** found that one of its blazers, advertised as a blend of lambswool and 30 percent cashmere, tested in the range of 10 to 30 percent cashmere. The company advised its operators to tell prospective purchasers of the variability and to offer $20 off the price to those who still wanted the jackets. Other sellers chose to take the "low road" and continued to advertise and sell their variable mix fibre sweaters and blazers at the higher percentage of cashmere.

There can be endless debates about what is right and what is wrong. Chapter 1 discusses some ethical standards that have been developed to provide guidance for individuals. Additionally, many companies are hiring full-time ethics officers. Often, these officers set up hotlines so that employees can call and register complaints or ask about the propriety of certain actions. However, as pointed out in an article in *Fortune*: "The old advice is still the best: Don't do anything on the job you wouldn't want your mother to read about with her morning coffee."[8]

[8] Kenneth Labich, "The New Crisis in Business Ethics," *Fortune* (April 20, 1992): 172.

Relevant Cost Analysis in Personal Decision Making

Finally, it is useful to note that relevant costing analysis is important in personal decision making. Nearly any short-term decision can be improved by following the decision model outlined in this chapter.

For many parents of young skiers, an important decision is whether to buy the child a new pair of skis or go with the seasonal rental approach. The problem, of course, is that children are growing, and a pair of skis that works this year may well not be the right size next year. Children also change their minds. The child who can't wait to get onto the slopes may be sick and tired of the sport after an unsuccessful morning. Or the child may decide to switch to snowboarding. Further complicating the problem is that so many alternatives are available—daily ski rental, seasonal ski rental, lease-to-own, purchasing new, or purchasing used. Computer scientists have actually developed a ski-rental algorithm to help people decide when skis should be bought versus rented. In the final analysis, parents use a combination of their budgets, their assessment of the probabilities that their children will enjoy skiing and will go frequently, and the importance of the "coolness factor" of snazzy graphics applied to the new skis.[9]

Throughout the years, many of our students have found it enlightening to use the model to consider their decisions to keep or buy a car, get a pet, choose a university, and so on. They can see that they have already implicitly used the decision-making model, and how explicit use can improve their decision making. They can also see how important qualitative factors are in those decisions, and in many cases they become more comfortable with the ultimate decision once they can see the legitimacy of relying on qualitative factors.

Summary of Learning Objectives

1. Describe the tactical decision-making model.

- Tactical decisions consist of choosing among alternatives with an immediate end in view.
  - Short term.
  - Larger strategic objectives are served.
- Six steps of the decision-making model are:
  - Recognize and define the problem.
  - Identify feasible alternatives.
  - Identify costs and benefits for each feasible alternative.
  - Total relevant costs and benefits for each alternative.
  - Assess qualitative factors.
  - Select best alternative.

2. Define the concept of relevant costs and revenues.

- Relevant costs are:
  - Future costs that differ across alternatives
  - Frequently variable costs—called flexible resources

[9] Nancy Keates, "The Cost of Taking Half Pints on the Half-Pipe," *The Wall Street Journal* (November 10, 2007): W1.

- Past costs:
  - Are sunk and never relevant
  - May be used to predict future costs

3. Explain how the activity resource usage model is used in assessing relevancy.

- Resources can be classified as flexible resources and committed resources.
  - Flexible resources are acquired as needed.
  - Committed resources are acquired in advance of usage.
- The cost of flexible resources is relevant.
- The cost of committed resources is relevant if demand changes across alternatives lead to a change in capacity.
- Changes in activity capacity cause resource spending to change.

4. Apply the tactical decision-making concepts in a variety of business situations.

- Make-or-buy decision
- Keep-or-drop decision
- Special-order decision
- Further processing of joint products

CORNERSTONES FOR CHAPTER 11

CORNERSTONE 11-1 The HOW and WHY of structuring a make-or-buy decision, page 556

CORNERSTONE 11-2 The HOW and WHY of structuring a keep-or-drop product line decision, page 559

CORNERSTONE 11-3 The HOW and WHY of structuring a special-order decision, page 563

CORNERSTONE 11-4 The HOW and WHY of structuring a sell at split-off or process further decision, page 565

Review Problem

Activity Resource Usage Model, Strategic Elements, and Relevant Costing

Perkins Company has idle capacity. Recently, Perkins received an offer to sell 2,000 units of one of its products to a new customer in a geographic region not normally serviced. The offering price is $10 per unit. The product normally sells for $14. The activity-based accounting system provides the following information:

	Cost Driver	Unused Capacity	Quantity Demanded*	Activity Rate**	
				Fixed	Variable
Direct materials	Units	0	2,000	—	$3.00
Direct labour	Direct labour hours	0	400	—	7.00
Setups	Setup hours	0	25	$50.00	8.00
Machining	Machine hours	6,000	4,000	4.00	1.00

*This represents only the amount of resources demanded by the special order being considered.
**Fixed activity rate is the price that must be paid per unit of activity capacity. The variable activity rate is the price per unit of resource for resources acquired as needed.

Although the fixed activity rate for setups is $50 per hour, any expansion of this resource must be acquired in blocks. The unit of purchase for setups is 100 hours of setup servicing. Thus, any expansion of setup activity must be done 100 hours at a time. The price per hour is the fixed activity rate.

Required:

1. Compute the change in income for Perkins Company if the order is accepted. Comment on whether or not the order should be accepted. (In particular, discuss the strategic issues.)
2. Suppose that the setup activity had 50 hours of unused capacity. How does this affect the analysis?

Solution:

1. The relevant costs are those that change if the order is accepted. These costs would consist of the variable activity costs (flexible resources) plus any cost of acquiring additional activity capacity (committed resources). The income will change by the following amount:

Revenues ($10 × 2,000 units)	$20,000
Less increase in resource spending:	
Direct materials ($3 × 2,000 units)	(6,000)
Direct labour ($7 × 400 direct labour hours)	(2,800)
Setups [($50 × 100 hours) + ($8 × 25 hours)]	(5,200)
Machining ($1 × 4,000 machine hours)	(4,000)
Income change	$ 2,000

   Special orders should be examined carefully before acceptance. This order offers an increase in income of $2,000, but it does require expansion of the setup activity capacity. If this expansion is short run in nature, then it may be worth it. If it entails a long-term commitment, then the company would be exchanging a one-year benefit of $2,000 for an annual commitment of $5,000. In this case, the order should be rejected. Even if the commitment is short term, other strategic factors need to be considered. Will this order affect any regular sales? Is the company looking for a permanent solution to its idle capacity, or are special orders becoming a habit (a response pattern that may eventually prove disastrous)? Will acceptance adversely affect the company's normal distribution channels? Acceptance of the order should be consistent with the company's strategic position.
2. If 50 hours of excess setup capacity exist, then the setup activity can absorb the special order's activity demands with no additional resource spending required for additional capacity. Thus, the profitability of the special order would be increased by $5,000 (the increase in resource spending that would have been required). Thus, total income would increase by $7,000 if the order is accepted.

Key Terms

Activity resource usage model, 553
Decision model, 550
Foreign trade zones (FTZs), 552
Keep-or-drop decision, 558
Make-or-buy decision, 555
Outsourcing, 555
Relevant costs (revenues), 551
Sell or process further, 562
Special-order decisions, 562
Sunk cost, 551
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Tactical decision making, 548
Tariff, 552

Discussion Questions

1. What is tactical decision making?
2. "Tactical decisions are often small-scale decisions that serve a larger purpose." Explain what this means.
3. What is tactical cost analysis? What steps in the tactical decision-making model correspond to tactical cost analysis?

4. Describe a tactical decision you personally have had to make. Apply the tactical decision-making model to your decision. How did it turn out? (*Hint:* You could discuss buying a car, choosing a university, buying a puppy, etc.)
5. What is a relevant cost? Explain why depreciation on an existing asset is always irrelevant.
6. Give an example of a future cost that is not relevant.
7. Relevant costs always determine which alternative should be chosen. Do you agree or disagree? Explain.
8. Can direct materials ever be irrelevant in a make-or-buy decision? Explain. Give an example of a fixed cost that is relevant.
9. What role do past costs play in tactical cost analysis?
10. When will flexible resources be relevant to a decision?
11. When will the cost of committed resources be relevant to a decision?
12. What are the main differences between a traditional and an activity-based make-or-buy analysis?
13. Explain why activity-based segmented reporting provides more insight concerning keep-or-drop decisions.
14. Should joint costs be considered in a sell-or-process-further decision? Explain.
15. Why would a firm ever offer a price on a product that is below its full cost?

Cornerstone Exercises

OBJECTIVE 2 4
CORNERSTONE 11-1

Cornerstone Exercise 11-1 MAKE-OR-BUY DECISION, ALTERNATIVES, RELEVANT COSTS

Each year, Subramanian Company produces 20,000 units of a component used in radar detectors. An outside supplier has offered to supply the part for $2.36. The unit cost is:

Direct materials	$0.50
Direct labour	0.62
Variable overhead	0.24
Fixed overhead	2.75
Total unit cost	$4.11

Overhead is applied on the basis of machine hours; the component requires 10,000 machine hours per year.

Required:

1. What are the alternatives for Subramanian Company?
2. Assume that none of the fixed cost is avoidable. List the relevant cost(s) of internal production and of external purchase.
3. Which alternative is more cost effective and by how much?
4. ***What if*** $37,000 of fixed overhead is rental of equipment used only in production of the component that can be avoided if the component is purchased? Which alternative is more cost effective and by how much?

OBJECTIVE 2 4
CORNERSTONE 11-2

Cornerstone Exercise 11-2 KEEP-OR-DROP DECISION, ALTERNATIVES, RELEVANT COSTS

Ambi Company makes three types of rug shampooers. Model 1 is the basic model rented through hardware stores and supermarkets. Model 2 is a more advanced model with both dry and wet vacuuming capabilities. Model 3 is the heavy duty riding shampooer sold to hotels and convention centres. A segmented income statement is shown below.

	Model 1	Model 2	Model 3	Total
Sales	$ 345,000	$ 618,000	$ 575,000	$1,538,000
Less variable costs of goods sold	(125,000)	(183,160)	(386,250)	(694,410)
Less commissions	(6,900)	(37,080)	(28,750)	(72,730)
Contribution margin	$ 213,100	$ 397,760	$ 160,000	770,860

	Model 1	Model 2	Model 3	Total
Less common fixed expenses:				
Fixed factory overhead				(398,000)
Fixed selling and administrative				(290,000)
Operating income				$ 82,860

While all models have positive contribution margins, Ambi Company is concerned because operating income is less than 10 percent of sales and is low for this type of company. The company's controller gathered additional information on fixed costs to see why they were so high. The following information on activities and drivers was gathered:

Activity	Activity Cost	Activity Driver	Driver Usage by Model		
			Model 1	Model 2	Model 3
Engineering	$ 30,000	Engineering hours	50	75	875
Setting up	180,000	Setup hours	2,500	7,500	20,000
Customer service	110,000	Service calls	1,000	1,500	17,500

In addition, Model 3 requires the rental of specialized equipment costing $20,000 per year.

Required:

1. Reformulate the segmented income statement using the additional information on activities.
2. Using your answer to Requirement 1, assume that Ambi Company is considering dropping any model with a negative product margin. What are the alternatives? Which alternative is more cost effective and by how much? (Assume that any traceable fixed costs can be avoided.)
3. ***What if*** Ambi Company can only avoid 375 hours of engineering time and 10,000 hours of setup time that are attributable to Model 3? How does that affect the alternatives presented in Requirement 2? Which alternative is more cost effective and by how much?

OBJECTIVE 2 4

CORNERSTONE 11-3

Cornerstone Exercise 11-3 SPECIAL-ORDER DECISION, ALTERNATIVES, RELEVANT COSTS

Zhang Leaf Paper Products Inc. manufactures boxed stationery for sale to specialty shops. Currently, the company is operating at 90 percent of capacity. A chain of drugstores has offered to buy 50,000 boxes of Zhang Leaf's blue-bordered thank you notes as long as the box can be customized with the drugstore chain's logo. While the normal selling price is $3.00 per box, the chain has offered just $2.45 per box. Zhang Leaf Paper Products can accommodate the special order without affecting current sales. Unit cost information for a box of thank you notes follows:

Direct materials	$1.22
Direct labour	0.25
Variable overhead	0.18
Fixed overhead	1.10
Total cost per box	$2.75

Fixed overhead is $420,000 per year and will not be affected by the special order. Normally, there is a commission of 10 percent of price; this will not be paid on the special order since the drugstore chain is dealing directly with the company. The special order will require additional fixed costs of $16,000 for the design and setup of the machinery to stamp the drugstore chain's logo on each box.

Required:

1. List the alternatives being considered. List the relevant benefits and costs for each alternative.
2. Which alternative is more cost effective and by how much?

3. ***What if*** Zhang Leaf Paper Products was operating at capacity and accepting the special order would require rejecting an equivalent number of boxes sold to existing customers? Which alternative would be better?

OBJECTIVE 2 4
CORNERSTONE 11-4

Cornerstone Exercise 11-4 SELL AT SPLIT-OFF OR PROCESS FURTHER DECISION, ALTERNATIVES, RELEVANT COSTS

Avalon Chemicals Company processes a number of chemical compounds for use in veterinary medicine. One compound is decomposed into two chemicals: avacol and selgene. The cost of processing one batch of compound is $74,000, and the result is 4,000 litres of avacol and 6,000 litres of selgene. Avalon Chemicals can sell the avacol at split-off for $13 per litre and the selgene for $4.50 per litre. Alternatively, the avacol can be processed further at a cost of $9 per litre (of avacol) into flourcine. It takes 2 litres of avacol for every litre of flourcine. A litre of flourcine sells for $46.

Required:

1. List the alternatives being considered.
2. List the relevant benefits and costs for each alternative.
3. Which alternative is more cost effective and by how much?
4. ***What if*** the production of avacol into flourcine required additional purchasing and quality inspection activity? Every 500 litres of avacol that undergo further processing require 20 more purchase orders at $10 each and 15 more quality inspection hours at $25 each. Which alternative would be better and by how much?

Exercises

OBJECTIVE 2

Exercise 11-5 DETERMINING RELEVANT COSTS

Six months ago, Lee Anna Martelli purchased a fire-engine red, used LeBaron convertible for $10,000. Lee Anna was looking forward to the feel of the sun on her shoulders and the wind whipping through her hair as she zipped along the highways of life. Unfortunately, the wind turned her hair into straw, and she didn't do much zipping along since the car spent so much of its time in the shop. So far, she has spent $1,200 on repairs, and she's afraid there is no end in sight. In fact, Lee Anna anticipates the following costs of restoration:

Rebuilt engine	$1,250
New paint job	560
Tires	460
New interior	500
Miscellaneous maintenance	340
Total	$3,110

On a visit to a used car dealer, Lee Anna found a five-year-old Honda CR-V in excellent condition for $9,100—Lee Anna thinks she might really be more the sport-utility type anyway. Lee Anna checked the Blue Book values and found that she can sell the LeBaron for only $3,600. If she buys the CR-V, she will pay cash but would need to sell the LeBaron.

Required:

1. In trying to decide whether to restore the LeBaron or buy the CR-V, Lee Anna is distressed because she has already spent $11,200 on the LeBaron. The investment seems too much to give up. How would you react to her concern?
2. List all costs that are relevant to Lee Anna's decision. What advice would you give her?

OBJECTIVE 2 3 4
SERVICE

Exercise 11-6 RESOURCE SUPPLY AND USAGE, SPECIAL ORDER, RELEVANCY

Barker Inc. has six salaried clerks to process purchase orders. Each clerk is paid a salary of $26,300 and is capable of processing as many as 6,500 purchase orders per year. Each clerk uses a PC and laser printer in processing orders. Time available on each PC system

is sufficient to process 6,500 orders per year. The depreciation on each PC system is $1,100 per year. In addition to the salaries, Barker spends $27,300 for forms, postage, and other supplies (assuming 39,000 purchase orders are processed). During the year, 38,200 orders were processed.

Required:

1. Classify the resources associated with purchasing as (1) flexible or (2) committed.
2. Compute the total activity availability, and break this into activity usage and unused activity.
3. Calculate the total cost of resources supplied (activity cost), and break this into the cost of activity used and the cost of unused activity.
4. (a) Suppose that a large special order will cause an additional 500 purchase orders. What purchasing costs are relevant? By how much will purchasing costs increase if the order is accepted? (b) Suppose that the special order causes 1,000 additional purchase orders. How will your answer to (a) change?

Exercise 11-7 RESOURCE SUPPLY AND USAGE, ADDING A SERVICE LINE, RELEVANCY

OBJECTIVE ➤ 2 3 4

SERVICE

Roxanne Sawchuk owns a beauty shop with eight hair and nail professionals. Her shop is relatively large and has four rooms at the back, three of which are currently empty (the fourth is used to store supplies). Roxanne's is popular and typically busy Monday through Friday all day and Saturday until noon. She has been thinking about adding a tanning salon in the back of the shop. She figures that she can buy two tanning beds for $10,000 each. The necessary supplies (cleaning materials, complimentary skin lotion in each room) will run about $450 per month. The extra electricity will cost about $100 per month. Currently, Roxanne pays part-time help to staff the front desk, make appointments, check clients in, and so on. For the hours that the beauty salon is open, the current staff can easily handle the additional tanning salon duties. However, Roxanne knows that she'll have to stay open an additional four hours each weeknight (from 5 p.m. until 9 p.m) as well as six hours on both Saturday and Sunday afternoons. Hiring additional staff for the tanning salon during those hours will cost about $8 per hour.

Required:

1. Classify the resources associated with the tanning salon as (1) flexible or (2) committed.
2. (a) Suppose that the tanning salon does very well and Roxanne decides to add one more tanning bed, using the third room at the back of the shop. What additional costs are relevant? (b) Suppose that Roxanne decides to add two more tanning beds? How will your answer to (a) change?

Exercise 11-8 SPECIAL-ORDER DECISION, TRADITIONAL ANALYSIS, QUALITATIVE ASPECTS

OBJECTIVE ➤ 4

Sportz-a-Lot Inc. manufactures toys and sporting equipment, including golf kits for preschoolers. A national sporting goods chain recently submitted a special order for 7,600 golf kits. Sportz-a-Lot was not operating at capacity and could use the extra business. Unfortunately, the order's offering price of $16.50 per golf kit was below the cost to produce the sets. The controller was opposed to taking a loss on the deal. However, the personnel manager argued in favour of accepting the order even though a loss would be incurred; it would avoid the problem of layoffs and would help maintain the community image of the company. The full cost to produce a golf kit is presented below.

Direct materials	$ 7.90
Direct labour	5.40
Variable overhead	4.75
Fixed overhead	3.10
Total	$21.15

No variable selling or administrative expenses would be associated with the order. Non-unit-level activity costs are a small percentage of total costs and are therefore not considered.

Required:

1. Assume that the company would accept the order only if it increased total profits. Should the company accept or reject the order? Provide supporting computations.
2. Suppose that Sportz-a-Lot has negotiated with the potential customer, and has determined that it can substitute cheaper materials, reducing direct materials cost by $1.09 per unit. In addition, the company's engineers have found a way to reduce direct labour cost by $2.40 per unit. Should the company accept or reject the order? Provide supporting computations.
3. Consider the personnel manager's concerns. Discuss the merits of accepting the order even if it decreases total profits.

OBJECTIVE 2 4

Exercise 11-9 MAKE-OR-BUY, TRADITIONAL ANALYSIS

Savard Company is currently manufacturing Part KAV-71, producing 35,000 units annually. The part is used in the production of several products made by Savard. The cost per unit for KAV-71 is as follows:

Direct materials	$53.80
Direct labour	12.00
Variable overhead	2.75
Fixed overhead	1.30
Total	$69.85

Of the total fixed overhead assigned to KAV-71, $12,950 is direct fixed overhead (the annual lease cost of machinery used to manufacture Part KAV-71), and the remainder is common fixed overhead. An outside supplier has offered to sell the part to Savard for $64. There is no alternative use for the facilities currently used to produce the part. No significant non-unit-based overhead costs are incurred.

Required:

1. Should Savard Company make or buy Part KAV-71?
2. What is the maximum amount per unit that Savard would be willing to pay to an outside supplier?

OBJECTIVE 3 4

Exercise 11-10 MAKE-OR-BUY, TRADITIONAL AND ABC ANALYSIS

Venable Inc., a manufacturer of snowmobiles, has just received an offer from a supplier to provide 3,000 units of a component used in its main product. The component is a track assembly that is currently produced internally. The supplier has offered to sell the track assembly for $64 per unit. Venable is currently using a traditional, unit-based costing system that assigns overhead to jobs on the basis of direct labour hours. The estimated traditional full cost of producing the track assembly is as follows:

Direct materials	$40.00
Direct labour	12.50
Variable overhead	6.00
Fixed overhead	40.00

Prior to making a decision, the company's CEO commissioned a special study to see whether there would be any decrease in the fixed overhead costs. The results of the study revealed the following:

3 setups—$1,350 each.

One half-time inspector is needed. The company already uses part-time inspectors hired through a temporary employment agency. The yearly cost of the part-time inspectors for the track assembly operation is $12,300 and could be totally avoided if the part were purchased.

Engineering work: 515 hours, $30/hour. (Although the work decreases by 515 hours, the engineer assigned to the track assembly line also spends time on other products, and there would be no reduction in his salary.)

260 fewer material moves at $35 per move.

Required:

1. Ignore the special study, and determine whether the track assembly should be produced internally or purchased from the supplier.
2. Now, using the special study data, repeat the analysis.
3. Discuss the qualitative factors that would affect the decision, including strategic implications.
4. After reviewing the special study, the controller made the following remark: "This study ignores the additional activity demands that purchasing would cause. For example, although the demand for inspecting the part on the production floor decreases, we may need to inspect the incoming parts in the receiving area. Will we actually save any inspection costs?" Is the controller right?

Exercise 11-11 RESOURCE USAGE MODEL, SPECIAL ORDER

OBJECTIVE 3 4

Ehrling Inc. manufactures metal racks for hanging clothing in retail stores. Ehrling was approached by the CEO of Carly's Corner, a regional nonprofit food bank, with an offer to buy 350 heavy-duty metal racks for storing canned goods and dry food products. While racks normally sell for $245 each, Carly's Corner offered $75 per rack. The CEO explained that the number of families they served had grown significantly over the past two years, and that the charity needed additional storage for the donated food items. Since Ehrling is operating at 80 percent of capacity, and Ehrling employees have "adopted" Carly's Corner as their annual charity, the company wants to make the special order work. Ehrling's controller looked into the cost of the storage racks using the following information from the activity-based accounting system:

		Unused	Quantity	Activity Rate**	
	Activity Driver	Capacity	Demanded*	Fixed	Variable
Direct materials	Number of racks	0	350	—	$82
Direct labour	Direct labour hours	0	525	—	15
Setups	Setup hours	60	1	$150	5
Inspection	Inspection hours	800	20	10	5
Machining	Machine hours	6,000	175	40	3

*This represents only the amount of resources demanded by the special order being considered.
**This is expected activity cost divided by activity capacity.

Expansion of activity capacity for setups, inspection, and machining must be done in steps. For setups, each step provides an additional 20 hours of setup activity and costs $3,000. For inspection, activity capacity is expanded by 2,000 hours per year, and the cost is $20,000 per year (the salary for an additional inspector). Machine capacity can be leased for a year at a rate of $40 per machine hour. Machine capacity must be acquired, however, in steps of 1,500 machine hours.

Required:

1. Compute the change in income for Ehrling Inc. if the order is accepted.
2. Does the order require any change in capacity for setups, inspection, or machining?
3. Suppose that the inspection activity can be eliminated for this order since the customer is in town and does not need to have the racks boxed and shipped. Because of this, direct materials can be reduced by $13 per unit, and direct labour can be reduced by 0.5 hour per unit. How is the analysis affected?
4. Ehrling can find no other cost saving measures for this special order. Why might the company decide to accept it even if it shows a loss?

OBJECTIVE 3 4

Exercise 11-12 KEEP-OR-DROP: TRADITIONAL VERSUS ACTIVITY-BASED ANALYSIS

Harding Ltd. produces two types of cough syrup: Basic and Multi-Symptom. Of the two, Basic is the more popular. Data concerning the two products follow:

	Basic	Multi-Symptom	Unused Capacity[a]	Units of Purchase[b]
Expected sales (in cases)	46,000	12,000	—	—
Selling price per case	$72	$192	—	—
Direct labour hours	38,000	12,000	—	As needed
Machine hours	11,500	3,000	—	2,500
Receiving orders	250	500	250	500
Packing orders	700	1,200	100	250
Material cost per case	$50	$80	—	—
Direct labour cost per case	$12	$15	—	—
Advertising costs	$100,000	$160,000	—	—

[a]Practical capacity less expected usage (all unused capacity is permanent).
[b]In some cases, activity capacity must be purchased in steps (whole units). These steps are provided as necessary. The cost per step is the fixed activity rate multiplied by the step units. The fixed activity rate is the expected fixed activity costs divided by practical activity capacity.

Annual overhead costs are listed below. These costs are classified as fixed or variable with respect to the appropriate activity driver.

Activity	Fixed[a]	Variable[b]
Direct labour benefits	$ 0	$200,000
Machine	200,000	250,000
Receiving	200,000	22,500
Packing	80,000	43,700
Total costs	$480,000	$516,200

[a]Costs associated with practical activity capacity. The machine fixed costs are all depreciation.
[b]These costs are for the actual levels of the cost driver.

Required:

1. Prepare a traditional segmented income statement, using a unit-level overhead rate based on direct labour hours. Using this approach, determine whether the Basic cough syrup product line should be kept or dropped.
2. Prepare an activity-based segmented income statement. Repeat the keep-or-drop analysis using an ABC approach.

OBJECTIVE 2 4

Exercise 11-13 SELL OR PROCESS FURTHER, BASIC ANALYSIS

Schulzer Ltd. is a pork processor. Its plants, located on the Prairies, produce several products from a common process: sirloin roasts, chops, spare ribs, and the residual. The roasts, chops, and spare ribs are packaged, branded, and sold to supermarkets. The residual consists of organ meats and leftover pieces that are sold to sausage and hot dog processors. The joint costs for a typical week are as follows:

Direct materials	$84,000
Direct labour	30,000
Overhead	18,000

The revenues from each product are as follows: sirloin roasts, $65,000; chops, $70,000; spare ribs, $33,000; and residual, $10,000.

Schulzer's management has learned that certain organ meats are a prized delicacy in Asia. They are considering separating those from the residual and selling them abroad for $56,000. This would bring the value of the residual down to $3,750. In addition, the organ meats would need to be packaged and then air freighted to Asia. Further processing cost per week is estimated to be $27,500 (the cost of renting additional packaging equipment, purchasing materials, and hiring additional direct labour). Transportation cost would be $11,900 per week. Finally, resource spending would need to be expanded

for other activities as well (purchasing, receiving, and internal shipping). The increase in resource spending for these activities is estimated to be $3,120 per week.

Required:

1. What is the gross profit earned by the original mix of products for one week?
2. Should the company separate the organ meats for shipment overseas or continue to sell them at split-off? What is the effect of the decision on weekly gross profit?

Exercise 11-14 RELEVANT COSTS, FOREIGN TRADE ZONES

OBJECTIVE 2

SERVICE

Grassley Ltd. is considering opening a new warehouse to serve the Maritime region. Dante Mauro, controller for Grassley, has been reading about the advantages of foreign trade zones. He wonders if locating in one would be of benefit to his company, which imports about 90 percent of its merchandise (chess sets from the Philippines, jewellery from Thailand, pottery from Mexico). Dante estimates that the new warehouse will store imported merchandise costing about $23.7 million per year. Inventory shrinkage at the warehouse (due to breakage and mishandling) is about 7 percent of the total. The average tariff rate on these imports is 5.5 percent.

Required:

1. If Grassley locates the warehouse in a foreign trade zone, how much will be saved in tariffs? Why?
2. Suppose that, on average, the merchandise stays in a Grassley warehouse for nine months before shipment to retailers. Carrying cost for Grassley is 8 percent per year. If Grassley locates the warehouse in a foreign trade zone, how much will be saved in carrying costs? What will the total tariff-related savings be? (Round your answers to the nearest dollar.)
3. Suppose that the shifting economic situation leads to a new tariff rate of 15 percent and a new carrying cost of 10 percent per year. To combat these increases, Grassley has instituted a total quality program emphasizing reducing shrinkage. The new shrinkage rate is 5 percent. Given this new information, if Grassley locates the warehouse in a foreign trade zone, how much will be saved in carrying costs? What will the total tariff-related savings be? (Round your answers to the nearest dollar.)

Exercise 11-15 PROVIDE IN-HOUSE OR OUTSOURCE DECISION, SERVICES, QUALITATIVE ASPECTS

OBJECTIVE 4

SERVICE

Tony and Tina Roselli own and run TNT's Pizza Restaurant. Tony is responsible for managing the day-to-day aspects, hiring workers, overseeing the kitchen, building, and grounds. He is the chief cook and handles all purchasing. Tina is the hostess and manages the front of the house (restaurant talk for the dining area). She schedules the wait staff, ensures that customers are well taken care of, and pitches in to bus tables and refill drinks as needed. Tina also handles the financial aspects of the business and is responsible for bookkeeping and tax compliance. Two years ago, Tony and Tina became parents of a baby boy, Joseph, nicknamed "LJ" for Little Joe. Tina brings LJ to work each day, and both Rosellis as well as the restaurant staff help out watching him. Recently, the restaurant has grown busier, so Tony and Tina expanded the hours of operation. As a result, the staff rarely has any free time and Tina feels she has too much to handle. Tony and Tina are considering outsourcing their bookkeeping and tax filing needs to a local accountant.

Typically, Tina spends 15 hours per month on bookkeeping and taxes. This increases to 40 hours in April. She uses a room off the kitchen as her office (a room that is sorely needed for additional food storage given the expansion). If Tina continues to do the financial work, the restaurant will need to make up for 75 percent of her time by hiring additional help at $10 per hour (hourly wage plus the restaurant's cost of employee benefits). The local accountant will charge $25 per hour for bookkeeping services; he expects this service to average eight hours per month. Taxes are filed quarterly for labour as well as GST and local taxes. These tax forms should cost about $75 per quarter. The annual income tax filing is estimated to cost $350, payable at the time of filing in April.

Required:

1. Given the information, determine whether Tina should do the bookkeeping and tax work in house or outsource it to the accountant.
2. Discuss the qualitative factors that would affect the decision, including strategic implications.

OBJECTIVE 4

SERVICE

Exercise 11-16 SPECIAL-ORDER DECISION, SERVICES, QUALITATIVE ASPECTS

Jason Rogers works full time for UPS and runs a lawn mowing service part time after work during the months of April through October. Jason has three men working with him, each of whom is paid $6 per lawn mowing. Jason has 30 residential customers who contract with him for once-weekly lawn mowing during the months of May through September, and twice per month mowings during April and October. On average, Jason charges $40 per lawn mowed. Recently, LStar Property Management Services asked Jason to mow the lawn at each of its 20 rental houses twice per month during the months of May through September. LStar has offered to pay $20 per lawn mowing, and would forgo the lawn edging that normally takes Jason's team about half of its regular mowing time. If Jason accepts the job, he can assign a two-man team to mow the rental house yards, and will have to buy an additional power lawn mower for about $350 used. Fuel to run the additional mower will be about $0.50 per mowing.

Required:

1. If Jason accepts the special order, by how much will his income increase or decrease?
2. What are some of the qualitative reasons why Jason might want to accept or decline the special order?

OBJECTIVE 4

SERVICE

Exercise 11-17 KEEP-OR-DROP, SERVICES, QUALITATIVE ASPECTS

Jem Farber owns Jem's Special Event Planning Service, a full-service event planner. Jem does much of the work herself and hires additional help as needed. She plans corporate events, weddings, and special occasion parties. Each of these is considered a separate line of business due to the specialized aspects of each type of event. Last year, Jem's accountant provided the following segmented income statement:

	Corporate	Wedding	Special Occasion	Total
Revenue	$ 55,300	$195,000	$168,000	$ 418,300
Less variable costs	(22,120)	(97,500)	(50,400)	(170,020)
Contribution margin	$ 33,180	$ 97,500	$117,600	248,280
Less common fixed expenses:				
Fixed operating expense				(175,000)
Fixed selling				(55,000)
Operating income				$ 18,280

Jem was not pleased with last year's results; corporate events were down considerably from the previous few years. In addition, she thinks that dealing with the corporate party-throwers may be more work than it is worth. Two important aspects of event planning are negotiating with vendors (e.g., caterers, florists, bands and orchestras, venues) on price and setting up for and being present at the event itself. The corporate negotiating seemed to consume extra time and their restrictions on the price they would pay made the negotiations particularly difficult. She decided to gather some data on the negotiation and setting-up activities:

	Corporate	Wedding	Special Occasion
Negotiating hours	400	1,200	400
Setting-up hours	100	400	500
Total cost of negotiating	$40,000		
Total cost of setting up	$60,000		

Required:

1. Prepare a segmented income statement using the activity data for negotiating and setting up. The total cost of these two activities can be subtracted from the fixed operating expense. The remaining fixed operating expense will be the common fixed operating expense. What does this income statement suggest about the relative profitability of the three product lines?
2. Jem believes that next year will be even worse. Her hunch is that corporate business will be down and that these clients will be especially intent on saving money by reducing the rate paid to Jem. She believes total corporate revenue may decrease by 25 percent overall, while the variable costs associated with those events will only decrease by 20 percent. Weddings, on the other hand, Jem expects to increase. Her reputation is growing and she thinks she can raise her revenues in this area by 15 percent even if the number of weddings does not increase. As a result, she expects variable costs of weddings to remain static. The special occasions (wedding anniversary parties, bar and bat mitzvahs, and so on) line is also expected to increase—with revenue and variable costs expected to increase by 10 percent. Jem does not know quite what to expect with respect to the negotiating and setting-up activities, so she thinks she'll just keep those constant for planning purposes. Prepare a segmented income statement using the activity data and these assumptions. What does this income statement suggest about dropping the corporate segment?

Problems

Problem 11-18 IDENTIFYING PROBLEMS AND ALTERNATIVES, RELEVANT COSTS

OBJECTIVE ➤ 1 2

Norton Products Inc. manufactures potentiometers. (A potentiometer is a device that adjusts electrical resistance.) Currently, all parts necessary for the assembly of products are produced internally. Norton has a single plant located in The Pas, Manitoba. The facilities for the manufacture of potentiometers are leased, with five years remaining on the lease. All equipment is owned by the company. Because of increases in demand, production has been expanded significantly over the five years of operation, straining the capacity of the leased facilities. Currently, the company needs more warehousing and office space, as well as more space for the production of plastic mouldings. The current output of these mouldings, used to make potentiometers, needs to be expanded to accommodate the increased demand for the main product.

Leo Tidwell, owner and president of Norton Products, has asked his vice president of marketing, John Tidwell, and his vice president of finance, Linda Thayn, to meet and discuss the problem of limited capacity. This is the second meeting the three have had concerning the problem. In the first meeting, Leo rejected Linda's proposal to build the company's own plant. He believed it was too risky to invest the capital necessary to build a plant at this stage of the company's development. The combination of leasing a larger facility and subleasing the current plant was also considered but was rejected; subleasing would be difficult, if not impossible. At the end of the first meeting, Leo asked John to explore the possibility of leasing another facility comparable to the current one. He also assigned Linda the task of identifying other possible solutions. As the second meeting began, Leo asked John to give a report on the leasing alternative.

JOHN: After some careful research, I'm afraid that the idea of leasing an additional plant is not a very good one. Although we have some space problems, our current level of production doesn't justify another plant. In fact, I expect it will be at least five years before we need to be concerned about expanding into another facility like the one we have now. My market studies reveal a modest growth in sales over the next five years. All this growth can be absorbed by our current production capacity. The large increases in demand that we experienced the past five years are not likely to be repeated. Leasing another plant would be an overkill solution.

LEO: Even modest growth will aggravate our current space problems. As you both know, we are already operating three production shifts. But, John, you are right—except for plastic mouldings, we could expand production, particularly during the graveyard shift. Linda, I hope that you have been successful in identifying some other possible solutions. Some fairly quick action is needed.

LINDA: Fortunately, I believe that I have two feasible alternatives. One is to rent an additional building to be used for warehousing. By transferring our warehousing needs to the new building, we will free up internal space for offices and for expanding the production of plastic mouldings. I have located a building within two kilometres of our plant that we could use. It has the capacity to handle our current needs and the modest growth that John mentioned. The second alternative may be even more attractive. We currently produce all the parts that we use to manufacture potentiometers, including shafts and bushings. In the past several months, the market has been flooded with these two parts. Prices have tumbled as a result. It might be better to buy shafts and bushings instead of making them. If we stop internal production of shafts and bushings, this would free up the space we need. Well, Leo, what do you think? Are these alternatives feasible? Or should I continue my search for additional solutions?

LEO: I like both alternatives. In fact, they are exactly the types of solutions we need to consider. All we have to do now is choose the one best for our company.

Required:

1. Define the problem facing Norton Products.
2. Identify all the alternatives that were considered by Norton Products. Which ones were classified as not feasible? Why? Now identify the feasible alternatives.
3. For the feasible alternatives, what are some potential costs and benefits associated with each alternative? Of the costs that you have identified, which do you think are relevant to the decision?

OBJECTIVE 2 4

SERVICE

Problem 11-19 KEEP-OR-DROP FOR SERVICE FIRM, COMPLEMENTARY EFFECTS, TRADITIONAL ANALYSIS

Devern Assurance Company provides both property and automobile insurance. The projected income statements for the two products are as follows:

	Property Insurance	Automobile Insurance
Sales	$4,200,000	$12,000,000
Less variable expenses	3,830,000	9,600,000
Contribution margin	370,000	2,400,000
Less direct fixed advertising expenses	400,000	500,000
Segment margin	(30,000)	1,900,000
Less common fixed expenses (allocated)	100,000	200,000
Operating income (loss)	$ (130,000)	$ 1,700,000

The president of the company is considering dropping the property insurance. However, some policyholders prefer having their property and automobile insurance with the same company, so if property insurance is dropped, sales of automobile insurance will drop by 12 percent. No significant non-unit-level activity costs are incurred.

Required:

1. If Devern Assurance Company drops property insurance, by how much will income increase or decrease? Provide supporting computations.
2. Assume that dropping all advertising for the property insurance line and increasing the corporate advertising budget by $450,000 will increase sales of property insurance by 10 percent and automobile insurance by 8 percent. Prepare a segmented income statement that reflects the effect of increased advertising. Should advertising be increased?

Problem 11-20 RESOURCE USAGE, SPECIAL ORDER

OBJECTIVE 3 4

SERVICE

St. John's Medical Centre (SJMC) has five medical technicians who are responsible for conducting cardiac catheterization testing in SJMC's Cath Lab. Each technician is paid a salary of $36,000 and is capable of conducting 1,000 procedures per year. The cardiac catheterization equipment is one year old and was purchased for $250,000. It is expected to last five years. The equipment's capacity is 25,000 procedures over its life. Depreciation is computed on a straight-line basis, with no salvage value expected. The reading of the catheterization results is conducted by an outside physician whose fee is $120 per test. The technician's report with the outside physician's note of results is sent to the referring physician. In addition to the salaries and equipment, SJMC spends $50,000 for supplies and other costs needed to operate the equipment (assuming 5,000 procedures are conducted). When SJMC purchased the equipment, it fully expected to perform 5,000 procedures per year. In fact, during its first year of operation, 5,000 procedures were run. However, a larger hospital has established a clinic in the city and will siphon off some of SJMC's business. During the coming years, SJMC expects to run only 4,200 cath procedures yearly. SJMC has been charging $850 for the procedure—enough to cover the direct costs of the procedure plus an assignment of general overhead (e.g., depreciation on the hospital building, lighting and heating, and janitorial services).

At the beginning of the second year, a hospital from a neighbouring community approached SJMC and offered to send its clients to SJMC for cardiac catheterization provided that the charge per procedure would be $550. The hospital estimates that it can provide about 500 patients per year. The hospital has indicated that the arrangement is temporary—for one year only. The hospital expects to have its own testing capabilities within one year.

Required:

1. Classify the resources associated with the cardiac catheterization activity into one of the following: (1) committed resources or (2) flexible resources.
2. Calculate the activity rate for the cardiac catheterization activity. Break the activity rate into fixed and variable components. Now, classify each activity resource as relevant or irrelevant with respect to the following alternatives: (1) accept the hospital's offer or (2) reject the hospital's offer. Explain your reasoning.
3. Assume that SJMC will accept the hospital's offer if it reduces the hospital's operating costs. Should the hospital's offer be accepted?
4. Jerold Bosserman, SJMC's controller, argued against accepting the hospital's offer. Instead, he argued that SJMC should be increasing the charge per procedure rather than accepting business that doesn't even cover full costs. He also was concerned about local physician reaction if word got out that SJMC was performing procedures for $550. Discuss the merits of Jerold's position. Include in your discussion an assessment of the price increase that would be needed if the objective is to maintain total revenues from cardiac catheterizations experienced in the first year of operation.
5. Chandra Danton, SJMC's administrator, has been informed that one of the Cath Lab technicians is leaving for an opportunity at a larger hospital. She met with the other technicians, and they agreed to increase their hours to pick up the slack so that SJMC won't need to hire another technician. By working a couple hours extra every week, each remaining technician can perform 1,050 procedures per year. They agreed to do this for an increase in salary of $2,000 per year. How does this outcome affect the analysis of the hospital's offer?
6. Assuming that SJMC wants to bring in the same revenues earned in the cardiac catheterization activity's first year less the reduction in resource spending attributable to using only four technicians, how much must SJMC charge for a procedure?

Problem 11-21 ACTIVITY-BASED RESOURCE USAGE MODEL, MAKE-OR-BUY

OBJECTIVE 3 4

Brandy Dees recently bought Blade Enterprises, a company that manufactures ice skates. Brandy decided to assume management responsibilities for the company and appointed herself president shortly after the purchase was completed. When she bought the

company, Brandy's investigation revealed that with the exception of the blades, all parts of the skates are produced internally. The investigation also revealed that Blade once produced the blades internally and still owned the equipment. The equipment was in good condition and was stored in a local warehouse. Blade's former owner had decided three years earlier to purchase the blades from external suppliers.

Brandy Dees is seriously considering making the blades instead of buying them from external suppliers. The blades are purchased in sets of two and cost $8 per set. Currently, 100,000 sets of blades are purchased annually.

Skates are produced in batches, according to shoe size. Production equipment must be reconfigured for each batch. The blades could be produced using an available area within the plant. Prime costs will average $5.00 per set. There is enough equipment to set up three lines of production, each capable of producing 80,000 sets of blades. A supervisor would need to be hired for each line. Each supervisor would be paid a salary of $40,000. Additionally, it would cost $1.50 per machine hour for power, oil, and other operating expenses. Since three types of blades would be produced, additional demands would be made on the setup activity. Other overhead activities affected include purchasing, inspection, and materials handling. The company's ABC system provides the following information about the current status of the overhead activities that would be affected. (The lumpy quantity indicates how much capacity must be purchased should any expansion of activity supply be needed—the units of purchase. The purchase cost per unit is the fixed activity rate. The variable rate is the cost per unit of resources acquired as needed for each activity.)

Activity	Cost Driver	Current Activity Capacity	Activity Usage	Lumpy Quantity	Fixed Activity Rate	Variable Activity Rate
Setups	Number of setups	1,000	800	100	$200	$500
Purchasing	Number of orders	50,000	47,000	5,000	10	0.50
Inspecting	Inspection hours	20,000	18,000	2,000	15	none
Materials handling	Number of moves	9,000	8,700	500	30	1.50

The demands that *production* of blades place on the overhead activities are as follows:

Activity	Resource Demands
Machining	50,000 machine hours
Setups	250 setups
Purchasing	4,000 purchase orders (associated with materials)
Inspection	1,500 inspection hours
Materials handling	650 moves

If the blades are made, the purchase of the blades from outside suppliers will cease. Therefore, purchase orders will decrease by 6,500 (the number associated with their purchase). Similarly, the moves for the handling of incoming blades will decrease by 400. Any unused activity capacity is viewed as permanent.

Required:

1. Should Blade make or buy the blades?
2. Explain how the ABC resource usage model helped in the analysis. Also, comment on how a conventional approach would have differed.

OBJECTIVE ➤ 2 4

SERVICE

Problem 11-22 MAKE-OR-BUY, TRADITIONAL ANALYSIS, QUALITATIVE CONSIDERATIONS

Beliveau Dental Services is part of a private clinic that operates in a large metropolitan area. Currently, Beliveau has its own dental laboratory to produce two varieties of porcelain crowns—all porcelain and porcelain fused to metal (PFM). The unit costs to produce the crowns are as follows:

	All Porcelain	PFM
Direct materials	$190	$ 80
Direct labour	50	20
Variable overhead	25	5
Fixed overhead	60	40
Total	$325	$145

Fixed overhead is detailed as follows:

Salary (supervisor)	$30,000
Depreciation	8,000
Rent (lab facility)	22,000

Overhead is applied on the basis of direct labour hours. The rates above were computed using 8,000 direct labour hours. No significant non-unit-level overhead costs are incurred.

A local dental laboratory has offered to supply Beliveau all the crowns it needs. Its price is $265 for all-porcelain crowns and $145 for porcelain-fused-to-metal crowns; however, the offer is conditional on supplying both types of crowns—it will not supply just one type for the price indicated. If the offer is accepted, the equipment used by Beliveau's laboratory would be scrapped (it is old and has no market value), and the lab facility would be closed. Beliveau uses 2,500 all-porcelain crowns and 1,000 porcelain-fused-to-metal crowns per year.

Required:

1. Should Beliveau continue to make its own crowns, or should they be purchased from the external supplier? What is the dollar effect of purchasing?
2. What qualitative factors should Beliveau consider in making this decision?
3. Suppose that the lab facility is owned rather than rented and that the $22,000 is depreciation rather than rent. What effect does this have on the analysis in Requirement 1?
4. Refer to the original data. Assume that the volume of crowns is 5,000 all porcelain and 2,000 porcelain fused to metal. Should Beliveau make or buy the crowns? Explain the outcome.

Problem 11-23 SELL OR PROCESS FURTHER

OBJECTIVE 4

Pharmaco Corporation buys three chemicals that are processed to produce two popular ingredients for liquid pain relievers. The three chemicals are in liquid form. The purchased chemicals are blended for two to three hours and then heated for 15 minutes. The results of the process are two separate ingredients, PR1 and PR2. For every 4,300 litres of chemicals used, 2,000 litres of each pain reliever are produced. The pain relievers are sold to companies that process them into their final form. The selling prices are $34 per litre for PR1 and $45 per litre for PR2. The costs to produce one batch (containing 2,000 litres of each chemical) are as follows:

Chemicals	$23,400
Direct labour	9,000
Catalyst	3,600
Overhead	8,000

The pain relievers are bottled in five-litre plastic containers and shipped. The cost of each container is $2.10. The costs of shipping are $0.50 per container.

Pharmaco Corporation could process PR1 further by mixing it with inert powders and flavouring to form tablets. The tablets can be sold directly to retail drug stores as a generic brand. If this route is taken, the revenue received per case of tablets would be $13.50, with eight cases produced by every litre of PR1. The costs of processing into tablets total $11.00 per litre of PR1. Packaging costs $5.16 per case. Shipping costs are $1.68 per case.

Required:

1. Should Pharmaco sell PR1 at split-off, or should PR1 be processed and sold as tablets?
2. If Pharmaco normally sells 26,000 litres of PR1 per year, what will be the difference in profits if PR1 is processed further?

OBJECTIVE 1 2 4

Problem 11-24 MAKE-OR-BUY, TRADITIONAL ANALYSIS

Morrill Company produces two different types of gauges: a density gauge and a thickness gauge. The segmented income statement for a typical quarter follows.

	Density Gauge	Thickness Gauge	Total
Sales	$150,000	$80,000	$230,000
Less variable expenses	80,000	46,000	126,000
Contribution margin	70,000	34,000	104,000
Less direct fixed expenses*	20,000	38,000	58,000
Segment margin	$ 50,000	$ (4,000)	46,000
Less common fixed expenses			30,000
Operating income			$ 16,000

*Includes depreciation.

The density gauge uses a subassembly that is purchased from an external supplier for $25 per unit. Each quarter, 2,000 subassemblies are purchased. All units produced are sold, and there are no ending inventories of subassemblies. Morrill is considering making the subassembly rather than buying it. Unit-level variable manufacturing costs are as follows:

Direct materials	$2
Direct labour	3
Variable overhead	2

No significant non-unit-level costs are incurred.

Morrill is considering two alternatives to supply the productive capacity for the subassembly.

1. Lease the needed space and equipment at a cost of $27,000 per quarter for the space and $10,000 per quarter for a supervisor. There are no other fixed expenses.
2. Drop the thickness gauge. The equipment could be adapted with virtually no cost and the existing space utilized to produce the subassembly. The direct fixed expenses, including supervision, would be $38,000, $8,000 of which is depreciation on equipment. If the thickness gauge is dropped, sales of the density gauge will not be affected.

Required:

1. Should Morrill Company make or buy the subassembly? If it makes the subassembly, which alternative should be chosen? Explain and provide supporting computations.
2. Suppose that dropping the thickness gauge will decrease sales of the density gauge by 10 percent. What effect does this have on the decision?
3. Assume that dropping the thickness gauge decreases sales of the density gauge by 10 percent and that 2,800 subassemblies are required per quarter. As before, assume that there are no ending inventories of subassemblies and that all units produced are sold. Assume also that the per-unit sales price and variable costs are the same as in Requirement 1. Include the leasing alternative in your consideration. Now, what is the correct decision?

OBJECTIVE 2

Problem 11-25 EXPORTING, FOREIGN TRADE ZONES

Qatar Company manufactures plain-paper fax machines in a small factory in Barrie, Ontario. Sales have increased by 50 percent in each of the past three years, as Qatar has expanded its market from Canada to the United States and Mexico. As a result, the

Barrie factory is at capacity. Beryl Adams, president of Qatar, has examined the situation and developed the following alternatives.

1. Add a permanent second shift at the plant. However, the semiskilled workers who assemble the fax machines are in short supply, and the wage rate of $15 per hour would probably have to be increased across the board to $18 per hour in order to attract sufficient workers from out of town. The total wage increase (including fringe benefits) would amount to $125,000. The heavier use of plant facilities would lead to increased plant maintenance and small tool cost.
2. Open a new plant and locate it in Mexico. Wages (including fringe benefits) would average $3.50 per hour. Investment in plant and equipment would amount to $300,000.
3. Open a new plant and locate it in a foreign trade zone, possibly in Quebec City. Wages would be somewhat lower than in Barrie, but higher than in Mexico. The advantages of postponing tariff payments on parts imported from Asia could amount to $50,000 per year.

Required:

Advise Beryl of the advantages and disadvantages of each of her alternatives.

CMA Problems

CMA Problem 11-1 SPECIAL ORDER, TRADITIONAL ANALYSIS*

OBJECTIVE 2 4

Caron Company manufactures two types of cold-pressed olive oil, Refined Oil and Top Quality Oil, out of a joint process. The joint (common) costs incurred are $84,000 for a standard production run that generates 40,000 litres of Refined Oil and 20,000 litres of Top Quality Oil. Additional processing costs beyond the split-off point are $2.25 per litre for Refined Oil and $1.80 per litre for Top Quality Oil. Refined Oil sells for $3.75 per litre, while Top Quality Oil sells for $6.80 per litre.

Marche LcBeau, a supermarket chain, has asked Caron to supply it with 40,000 litres of Top Quality Oil at a price of $6.30 per litre. Marche LcBeau plans to have the oil bottled with its own label.

If Caron accepts the order, it will save $0.10 per litre in packaging of Top Quality Oil. There is sufficient excess capacity for the order. However, the market for Refined Oil is saturated, and any additional sales of Refined Oil would take place at a price of $2.15 per litre. Assume that no significant non-unit-level activity costs are incurred.

Required:

1. What is the profit normally earned on one production run of Refined Oil and Top Quality Oil?
2. Should Caron accept the special order? Explain. *(CMA adapted)*

CMA Problem 11-2 PLANT SHUTDOWN OR CONTINUE OPERATIONS, QUALITATIVE CONSIDERATIONS, TRADITIONAL ANALYSIS*

OBJECTIVE 2 4

KarlAuto Corporation manufactures automobiles, vans, and trucks. Among the various KarlAuto plants throughout Canada is the Regina plant, where vinyl covers and upholstery fabric are sewn. These are used to cover interior seating and other surfaces of KarlAuto products.

Pam Teegin is the plant manager for the Regina cover plant—the first KarlAuto plant in the region. As other area plants were opened, Teegin, in recognition of her management ability, was given the responsibility to manage them. Teegin functions as a regional manager, although the budget for her and her staff is charged to the Regina plant.

Teegin has just received a report indicating that KarlAuto could purchase the entire annual output of the Regina cover plant from outside suppliers for $32 million. Teegin was astonished at the low outside price, because the budget for the Regina plant's operating costs was set at $56.45 million. Teegin believes that the Regina plant will have to close down operations in order to realize the $24.45 million in annual cost savings.

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The budget (in thousands) for the Regina plant's operating costs for the coming year follows:

Materials		$12,000
Labour:		
Direct	$13,800	
Supervision	3,750	
Indirect plant	4,300	21,850
Overhead:		
Depreciation—Equipment	5,000	
Depreciation—Building	3,000	
Pension expense	5,600	
Plant manager and staff	3,000	
Corporate allocation	6,000	22,600
Total budgeted costs		$56,450

Additional facts regarding the plant's operations are as follows:

Due to the Regina plant's commitment to use high-quality fabrics in all of its products, the Purchasing Department was instructed to place blanket orders with major suppliers to ensure the receipt of sufficient materials for the coming year. If these orders are cancelled as a consequence of the plant closing, termination charges would amount to 18 percent of the cost of direct materials.

Approximately 600 plant employees will lose their jobs if the plant is closed. This includes all direct labourers and supervisors as well as the plumbers, electricians, and other skilled workers classified as indirect plant workers. Some would be able to find new jobs, but many others would have difficulty. All employees would have difficulty matching the Regina plant's base pay of $29.40 per hour, the highest in the area. A clause in the Regina plant's contract with the union may help some employees; the company must provide employment assistance to its former employees for 12 months after a plant closing. The estimated cost to administer this service would be $1 million for the year.

Some employees would probably elect early retirement because the company has an excellent pension plan. In fact, $4.6 million of next year's pension expense would continue whether or not the plant is open.

Teegin and her staff would not be affected by the closing of the Regina plant. They would still be responsible for administering three other area plants.

Equipment depreciation for the plant is considered to be a variable cost and the units-of-production method is used to depreciate equipment; the Regina plant is the only KarlAuto plant to use this depreciation method. However, it uses the customary straight-line method to depreciate its building.

Required:

1. Prepare a quantitative analysis to help in deciding whether or not to close the Regina plant. Explain how you treated the nonrecurring relevant costs.
2. Consider the analysis in Requirement 1, and add to it the qualitative factors that you believe are important to the decision. What is your decision? Would you close the plant? Explain. *(CMA adapted)*

The Collabourative Learning Exercises can be found on the product support site at ***www.hansen1ce.nelson.com***.

After studying this chapter, you should be able to:

- ➤1 Discuss basic pricing concepts.
- ➤2 Calculate a markup on cost and a target cost.
- ➤3 Discuss the impact of the legal system and ethics on pricing.
- ➤4 Discuss the variations in price, cost, and profit over the product life cycle.
- ➤5 Explain why firms measure profit, and calculate measures of profit using absorption and variable costing.
- ➤6 Compute the sales price, price volume, contribution margin, contribution margin volume, sales mix, market share, and market size variances.
- ➤7 Describe some of the limitations of profit measurement.

CHAPTER 12

Pricing and Profitability Analysis

Henry Ford said, "A business that does not make a profit for the buyer of a commodity, as well as for the seller, is not a good business. Buyer and seller must both be wealthier in some way as a result of a transaction, else the balance is broken."[1] Ford reminds us that the relationship between buyer and seller is an exchange relationship. Both expect to profit from it. Typically, we measure profit as the difference between revenues and costs. Price and revenue will be discussed first. Then, we will look at profit—the interplay of price and cost.

Basic Pricing Concepts

OBJECTIVE ➤1
Discuss basic pricing concepts.

One of the more difficult decisions facing a company is pricing. The accountant is the primary resource the firm turns to when financial data are needed, whether that information relates to cost or to price. Therefore, accountants must be familiar with

[1] Henry Ford, *Today and Tomorrow* (Portland, OR: Productivity Press, 1926, reprinted in 1988).

sources of revenue data as well as the economic and marketing concepts needed to interpret those data.

Demand and Supply

Customers want high-quality goods and services at a low price. Although customer demand is studied in detail in marketing classes and demand and supply in economics courses, accountants need to be aware of the way demand interacts with supply.

With all else equal, customers will buy more at lower prices and less at higher prices. Producers, on the other hand, are able to supply more at higher prices than they can at lower prices. The market-clearing or equilibrium price is located at the intersection of the supply and demand curves. At this price, the amount that producers supply just equals the amount that consumers demand. If firms charge a price that is higher than the market-clearing price, demand falls short of supply. Producers see inventories pile up as consumers buy other goods. If the price is lower than the market-clearing price, everything that is produced is bought. Shortages and backlogs occur, signalling the need to increase production and/or to raise prices.

Factors other than price that influence demand include consumer income, quality of goods offered for sale, availability of substitutes, demand for complementary goods, whether the good is a necessity or a luxury, and so on. However, the basic demand-supply relationship remains, and producers know that raising prices nearly inevitably results in less sold. Price elasticity and market structure are two factors that influence companies' ability to adjust price.

Price Elasticity of Demand

Since price affects quantity sold, producers want to know just how much a price change will change quantity demanded. **Price elasticity of demand** is measured as the percentage change in quantity divided by the percentage change in price. If demand is relatively elastic, a small percent change in price will lead to a greater percent change in quantity demanded. The opposite is true for inelastic demand.

Goods that are price elastic tend to have many substitutes, are not necessities, and take a relatively large amount of consumer income. The demand for movie tickets, restaurant meals, and automobiles is relatively elastic.

Price-inelastic goods have few substitutes, are necessities, or constitute a relatively small percentage of consumer income. Prescription drugs, electricity, and toothpicks are examples of price-inelastic goods. While price elasticity of demand is difficult to compute in real-world situations, it is possible to see its effects at work.

For example, **Unilever**, maker of Dove soap, Lipton teas, and Hellmann's mayonnaise, found its profit margins slipping in 2008 after it raised prices on many products. Demand fell precipitously, leading to falling profit margins. The new CEO, Paul Polman, quickly reversed that strategy, lowering prices and increasing quantity sold. Apparently, many of Unilever's products face elastic demand. The various soaps, teas, and so on, have numerous competitors. While a consumer may like Dove soap, for example, a price increase may send him or her to another brand.[2]

Other companies may have products with inelastic demand. For example, airlines define their core market as business travellers, who have inelastic demand for air travel. They need the flexibility to purchase tickets at the last minute, to change reservations, and to fly during the work week. Prices for tickets bought under these circumstances stay relatively high.

[2] Aaron O. Patrick, "Unilever CEO's Push to Cut Prices Drives Increase in Sales," *The Wall Street Journal* (August 7, 2009): B1.

Types of Market Structure and Price

Market structure affects price, as well as the costs necessary to support that price. In general, there are four types of market structure: perfect competition, monopolistic competition, oligopoly, and monopoly. These markets differ according to the number of buyers and sellers, the uniqueness of the product, and the relative ease of entry by firms into and out of the market (i.e., barriers to entry).

The **perfectly competitive market** has many buyers and sellers—no one of which is large enough to influence the market—a homogeneous product, and easy entry into and exit from the industry. Firms in a perfectly competitive market cannot charge a higher price than the market price because no one would buy their product, and they will not set a lower price because they can sell all they can produce at the market price.

At the opposite extreme is a monopoly. In a **monopoly**, barriers to entry are so high that there is only one firm in the market and the product is unique. The monopolistic firm is a price setter. While the monopolist sets the price, that does not mean it can force consumers to buy. It does mean that a somewhat higher price (with a lower quantity sold) can be set than would be set in a competitive market. Some monopolies have legally enforced barriers to entry (e.g., **Canada Post**). Other firms are monopolies because of patent protection, specialized knowledge, or exceptionally high-cost production equipment. Pharmaceutical companies have a monopoly on new drugs due to patent protection. When the patent expires, generic drug companies can produce it, and the price of the drug plummets.

Monopolistic competition has characteristics of both monopoly and perfect competition, but it is much closer to the competitive situation. There are many sellers and buyers, but the products are differentiated on some basis. Restaurants are good examples of monopolistic competitors. Each restaurant serves food but attempts to differentiate itself in some way—ethnic style of food, closeness to work or schools, availability of a party room, gourmet versus casual atmosphere, and so on. The end result is to slightly raise prices above the perfectly competitive price, as customers agree to pay a little more for the unique feature that appeals to them.

An **oligopoly** is characterized by a few sellers. Typically, barriers to entry are high, and they are usually cost related. For example, the cereal industry is dominated by **Kellogg's**, **General Mills**, and **Quaker Oats**. The reason is not the high cost of manufacturing corn flakes. Instead, the huge selling expenditures (e.g., advertising and shelf space fees) of the big three effectively prevent smaller companies from entering the market.

The various types of market structure and their characteristics are summarized in Exhibit 12-1. Companies must be aware of the market structure in which they operate in order to understand their pricing options. Note that these market structures also have implications for the supply or cost side. The firm in the perfectly competitive industry has lower marketing costs (advertising, positioning, discounting, coupons) than the firm in the monopolistically competitive industry, which must constantly reinforce the consumer's perception of its product's uniqueness. The monopolist typically incurs expenses to protect its monopoly position, often through legal fees and lobbying (included in administrative expenses).

Exhibit 12-1

Characteristics of the Four Basic Types of Market Structure

Market Structure Type	Number of Firms in Industry	Barriers to Entry	Uniqueness of Product	Expenses Related to Structure Type
Perfect competition	Many	Very low	Not unique	No special expenses
Monopolistic competition	Many	Low	Some unique features	Advertising, coupons, costs of differentiation
Oligopoly	Few	High	Fairly unique	Costs of differentiation, advertising, rebates, coupons
Monopoly	One	Very high	Very unique	Legal and lobbying expenditures

OBJECTIVE 2
Calculate a markup on cost and a target cost.

Cost and Pricing Policies

Companies use various strategies to set price. Since cost is an important determinant of supply and known to the producer, many companies base price on cost. Still other companies use a target-costing strategy, or strategies based on the initial conditions in the market.

Cost-Based Pricing

Demand is one side of the pricing equation; supply is the other side. Since revenue must cover cost for the firm to make a profit, many companies start with cost to determine price. That is, they calculate product cost and add the desired profit. The mechanics of this approach are straightforward. Usually, there is some cost base and a markup. The **markup** is a percentage applied to base cost; it includes desired profit and any costs not included in the base cost. Companies that bid for jobs routinely base bid price on cost. Cornerstone 12-1 shows the how and why of calculating a markup on cost.

As can be seen in Cornerstone 12-1, the markup on cost of goods sold is 43 percent. Notice that the 43 percent markup covers both profit and selling and administrative expenses. The markup percentage of 186 percent of direct materials cost would yield the same amount of profit, assuming the level of operations and other expenses remained stable. The markup percentage on direct materials covers direct labour, overhead, selling and administrative expenses, and profit. The choice of base and markup percentage generally rests on convenience.

When the markup percentages calculated in Cornerstone 12-1 were used in determining bid price, they were initial prices. Chris can adjust the price based on her knowledge of competition for this type of job and other factors. The markup is a guideline, not an absolute rule.

If a company actually sets its prices based on markup percentages, is it guaranteed to make a profit? Not at all. If very few jobs are won, the entire markup will go toward selling and administrative expenses, the costs not explicitly included in the pricing calculations.

Markup pricing is often used by retail stores, and their typical markup is 100 percent of cost. If a sweater is purchased by Graham Department Store for $24, the retail price marked is $48 [$24 + (1.00 × $24)]. That 100 percent markup is meant to cover the salaries of the clerks, payment for space and equipment (cash registers, etc.), utilities, advertising, and so on, as well as profit. A major advantage of markup pricing is that standard markups are easy to apply. Consider the difficulty of setting a price for every piece of merchandise in a store. For example, **The Bay** department store stocks a wide variety of goods, from glassware and pottery to furniture and textiles. Assessing the supply and demand characteristics of each item is time consuming. It is much simpler to apply a uniform markup to cost and then adjust prices as needed if less is demanded than anticipated.

Target Costing and Pricing

Most North American companies, and nearly all European firms, set the price of a new product as the sum of the costs and the desired profit. The rationale is that the company must earn sufficient revenues to cover all costs and yield a profit. Peter Drucker writes, "This is true but irrelevant: Customers do not see it as their job to ensure manufacturers a profit. The only sound way to price is to start out with what the market is willing to pay."[3]

[3] Peter Drucker, "The Five Deadly Business Sins," *The Wall Street Journal* (October 21, 1993): A22.

The HOW and WHY of Calculating a Markup on Cost

CORNERSTONE 12-1

Information:

AudioPro Company, owned and operated by Chris Brown, sells and installs audio equipment in homes and vehicles. Direct materials and direct labour costs are easy to trace to the jobs. Assemblers receive, on average, $12 per hour. AudioPro's income statement for last year is as follows.

Revenues		$350,350
Cost of goods sold:		
Direct materials	$122,500	
Direct labour	73,500	
Overhead	49,000	245,000
Gross profit		105,350
Selling and administrative expenses		25,000
Operating income		$ 80,350

Chris wants to find a markup on cost of goods sold that will allow her to earn about the same amount of profit on each job as was earned last year.

Why:

Firms use a markup on cost as an easy way to price items so that, in general, all other costs and profit are included in the price. The cost is a known quantity and must be covered by price in order for the firm to earn a profit.

Required:

1. What is the markup on cost of goods sold (COGS) that will maintain the same profit as last year?
2. Suppose that Chris wants to expand her company's product line to include automobile alarm systems and electronic remote car door openers. She estimates the following costs for the sale and installation of one electronic remote car door opener.

Direct materials	$ 80.60
Direct labour (3 hours × $12)	36.00
Applied overhead	23.40
Total cost	$140.00

   What is the price Chris will use for this new product given the markup percentage calculated in Requirement 1?
3. ***What if*** Chris wants to calculate a markup on direct materials cost, since it is the largest cost of doing business? What is the markup on direct materials cost that will maintain the same profit as last year? What is the bid price Chris will use for the job given in Requirement 2 if the markup percentage is calculated on the basis of direct materials cost?

Solution:

1. The markup percentage must include all costs that are not a part of cost of goods sold plus desired profit.

$$\begin{aligned}\text{Markup on COGS} &= (\text{Selling and administrative expenses} \\ &\quad + \text{Operating income})/\text{COGS} \\ &= (\$25{,}000 + \$80{,}350)/\$245{,}000 \\ &= 0.43, \text{ or } 43\% \text{ of cost of goods sold}\end{aligned}$$

CORNERSTONE 12-1 *(continued)*

2. Price for new product = \$140 + (0.43 × \$140) = \$140 + \$60.20 = \$200.20
   = \$140 × 1.43 = \$200.20

3. Markup on direct materials = (Direct labour + Overhead + Selling and administrative expenses + Operating income)/Direct materials
   = (\$73,500 + \$49,000 + \$25,000 + \$80,350)/\$122,500
   = 1.86, or 186% of direct materials cost

   Bid price = \$80.60 + (1.86 × \$80.60) = \$80.60 + \$149.92
   = \$230.52 (rounded)

Target costing sets the cost of a product or service based on the price (target price) that customers are willing to pay. The Marketing Department determines what characteristics and price for a product are most acceptable to consumers. Then, it is the job of the company's engineers to design and develop the product such that cost and profit can be covered by that price. Japanese firms have been doing this for years; North American companies are beginning to use target costing.

Retail stores engage in a form of target costing when they look for goods that can be priced at a particular level to appeal to customers.

For example, many department stores work with clothing companies to develop house labels. The house label goods are typically good quality items that cost less and are priced lower than comparable name brand items. The house label gives the store flexibility. The store is not in the business of manufacturing sweaters, for example, but can find a source that will deliver sweaters of particular quality for the cost that will allow the store to achieve a target price and profit. Kenmore and Craftsman are house brands of **Sears**, and MasterCraft is a house brand of **Canadian Tire**.

Let's return to the AudioPro Company example in Cornerstone 12-1. Suppose Chris finds that other aftermarket audio installers price the remote car door opener at \$155, while her initial price was \$200.20. Should she drop her plans to expand into this product line? No, not if she can tailor her price to the market price. Recall that the original price called for \$80 of direct materials and \$36 of direct labour. Perhaps Chris could offer one remote device instead of two, saving \$15 in cost. In addition, she might be able to shave some time off the direct labour, once the workers are trained and able to work more efficiently. This would result in \$16 of savings. Prime cost would be \$85.60 (\$80.60 − \$15 + \$36 − \$16) instead of the original \$116.60.

AudioPro Company applies overhead at the rate of 65 percent of direct labour cost. However, Chris must think carefully about this job. Perhaps somewhat less overhead will be incurred because purchasing is reduced. (Only one reliable supplier is needed, and the tools and facilities can be shared with the audio installation.) Perhaps overhead for this job will amount to \$10 (50 percent of direct labour). That would make the cost of one job \$95.60 (\$65.60 + \$20 + \$10).

Now, if the standard markup of 43 percent is applied, the price would be \$137, well within the other firms' price of \$155. As you can see, target costing is an iterative process. Chris will go through the cycle until she either achieves the target cost or determines that she cannot. Note, however, that target costing has given Chris a chance to develop a profitable market—a chance she might not have had if the original cost-based price had been set.

Target costing involves much more upfront work than cost-based pricing. However, let's not forget the additional work that must be done if the cost-based price turns out to be higher than what customers will accept. Then, the arduous task of bringing costs into line to support a lower price, or the opportunity cost of missing the market altogether, begins.

Other Pricing Policies

Penetration pricing is the pricing of a new product at a low initial price, perhaps even lower than cost, to build market share quickly. This is useful when the product or service is new and customers have great uncertainty as to its value. Penetration pricing is not predatory pricing; the important difference is the intent. The penetration price is not meant to destroy competition. Accountants, lawyers, and other professionals with new practices often use penetration pricing to establish a customer base.

Price skimming means that a higher price is charged when a product or service is first introduced. In essence, the company skims the cream off the market. It is used most effectively when the product is new, a small group of consumers values it, and the company enjoys a monopolistic advantage. Companies that engage in price skimming are hoping to recoup the expenses of research and development through high initial pricing. A cost consideration is that, in the start-up phase of production, economies of scale and learning effects have not occurred.

For example, in the late 1960s, **Hewlett-Packard** produced hand-held calculators. These were truly novel and very expensive. Priced at over $400, only scientists and engineers, who used the calculators in their work, felt the need for this product. As the market for hand-held calculators grew and technology improved, economies of scale kicked in, and the cost and price dropped dramatically. By the 1980s, tiny solar calculators were being given away as enticements to new subscribers of magazines.

Closely related to skimming is price gouging. **Price gouging** is said to occur when firms with market power price products "too high." How high is too high? Surely, cost is a consideration. Any time price just covers cost, gouging does not occur. This is why many firms go to considerable trouble to explain their cost structure and point out costs that consumers may not realize exist. Pharmaceutical companies, for example, emphasize the research and development costs associated with new drugs. When a high price is not clearly supported by cost, buyers take offence.

The Legal System and Pricing

OBJECTIVE 3
Discuss the impact of the legal system and ethics on pricing.

Government also plays an important role in pricing. Over time, many laws have been passed regulating how firms can set prices. The basic principle behind much pricing regulation is that competition is good and should be encouraged. Therefore, collusion by companies to set prices and deliberate attempts to drive competitors out of business are prohibited.

Predatory Pricing

Predatory pricing is the practice of setting prices below cost for the purpose of injuring competitors and eliminating competition. It is important to note that pricing below cost is not necessarily predatory pricing. Companies frequently price an item below cost, by running weekly specials in a grocery store, or practising penetration pricing, for example. Twenty-two U.S. states have laws against predatory pricing, each differing somewhat in definition and rules.

In 2001, **Air Canada**'s dominance of the Canadian airline sector was challenged in court by the country's antitrust watchdog, which charged it with predatory pricing against two smaller rivals. On March 8, 2001, Canada's Competition Bureau announced that it would ask the Competition Tribunal, a specialized

court that rules on antitrust matters, to issue an order prohibiting Air Canada from pricing its fares below cost in eastern Canada.

Air Canada's pricing changes were squeezing low-cost carriers **CanJet** (based in Halifax) and **WestJet** (based in Calgary) out of the market, the bureau said. The bureau wanted Air Canada to stop operating flights in eastern Canada at fares that do not cover its "avoidable cost" of providing the service.

"The bureau believes Air Canada's pricing and capacity management would result in WestJet and CanJet abandoning these routes," said Conrad von Finckenstein, Canada's commissioner of competition. "It is concerned their exit will result in higher prices in the long term. With the ongoing restructuring of the airline industry, the bureau is determined to ensure that new entrants have a fair opportunity to compete."

Montreal-based Air Canada, which controlled some 80 percent of Canada's domestic airline market and was the world's eleventh-largest carrier at the time, said it would "vigorously challenge" the Competition Bureau's allegations.

Air Canada took issue with the bureau's interpretation of avoidable costs, which included fuel, labour, and aircraft expenses that would have been avoided if the service or flight had not been provided. It also asked for an expedited hearing before the Competition Tribunal to clarify the rules on pricing in the Canadian airline industry.

Predatory pricing on the international market is called **dumping**, which occurs when companies sell below cost in other countries, and domestic industry is injured. The defence against a charge of dumping is demonstrating that the price is indeed above or equal to costs, or that domestic industry is unhurt.

Price Discrimination

Price discrimination refers to the charging of different prices to different customers for essentially the same product. In the United States, price discrimination was covered by the landmark Robinson-Patman Act of 1936. In Canada, such matters are covered by the Competition Act, the oldest antitrust statute in the Western world. Enacted in 1889, the Competition Act makes it an offence to adopt a practice of granting a discount, rebate, price concession, allowance, or any other price-related advantage to one customer—that is, to not make the same advantage available to competing customers who purchase like quantity and quality.

Besides price discrimination, the Competition Act covers price fixing, bid rigging, exclusive dealing, refusal to deal, promotional allowance, predatory pricing, tied selling (requiring a customer to buy a product as a condition of supplying the customer with another product), market restrictions (requiring a customer to sell a product only in a defined market as a condition of supplying that product), and so on. Price discrimination under certain specified conditions may be allowed: (1) if the competitive situation demands it and (2) if costs (including costs of manufacture, sale, or delivery) can justify the lower price. Clearly, this second condition is important for the accountant, as a lower price offered to one customer must be justified by identifiable cost savings. Additionally, the amount of the discount must be at least equalled by the amount of cost saved.

The burden of proof for firms accused of violating the Competition Act is on the firms. The cost justification argument must be buttressed by substantial cost data. Proving a cost justification is an absolute defence. The availability of large databases, the development of activity-based costing, and powerful computing make it easier to justify costs. Still, problems remain. Cost allocations make such determinations particularly thorny. In justifying quantity discounts to larger companies, a company might keep track of sales calls, differences in time and labour required to make small and large deliveries, and so on.

In computing a cost differential, the company must create classes of customers based on the average costs of selling to those customers and then charge all customers in each group a cost-justifiable price. Cornerstone 12-2 shows the how and why of calculating cost and profit by customer segment.

The HOW and WHY of Calculating Cost and Profit by Customer Class

CORNERSTONE 12-2

Information:

Cobalt Inc. manufactures vitamin supplements with an average manufacturing cost of $163 per case (a case contains 100 bottles of vitamins). Cobalt Inc. sold 250,000 cases last year to the following three classes of customer.

Customer	Price per Case	Cases Sold
Large drugstore chain	$200	125,000
Small local pharmacies	232	100,000
Individual health clubs	250	25,000

The large drugstore chain special labelling costs $0.03 per bottle. The chain orders through electronic data interchange (EDI), which costs Cobalt about $50,000 annually in operating expenses and depreciation. Cobalt pays all shipping costs, which amounted to $1.5 million last year.

The small local pharmacies order in smaller lots that require special picking and packing in the factory; the special handling adds $20 to the cost of each case sold. Sales commissions to the independent jobbers who sell Cobalt products to the pharmacies average 10 percent of sales. Bad debts expense amounts to 1 percent of sales.

Individual health clubs purchase vitamins in even smaller lots; the special picking and packaging costs average $30 per case. There are no sales commissions for the health clubs. Instead, Cobalt advertises in health club management magazines, accepts orders by phone, and supplies point-of-sale posters and displays for the clubs. These marketing costs are $100,000 per year. Bad debts expense for this class of customer averages 10 percent.

Why:

Firms covered by price discrimination laws must be sure that price differentials are supported by cost differentials. On average, profit for each customer type is about the same.

Required:

1. Calculate the total cost per case for each of the three customer classes.
2. Using the costs from Requirement 1, calculate the profit per case per customer class. Does the cost analysis support the charging of different prices? Why or why not?
3. ***What if*** Cobalt charged the average price per case to all customer classes? How would that affect the profit percentages?

Solution:

1.

Chain store:	
Manufacturing cost per case	$163.00
Special labelling cost ($0.03 × 100)	3.00
EDI ($50,000/125,000 cases)	0.40
Shipping ($1,500,000/125,000 cases)	12.00
Total cost per case	$178.40
Small pharmacies:	
Manufacturing cost per case	$163.00
Special handling per case	20.00

CORNERSTONE 12-2 *(continued)*

Sales commission ($232 × 0.10)	$ 23.20
Bad debts expense ($232 × 0.01)	2.32
Total cost per case	$208.52
Health clubs:	
Manufacturing cost per case	$163.00
Special handling per case	30.00
Selling expense ($100,000/25,000 cases)	4.00
Bad debts expense ($250 × 0.10)	25.00
Total cost per case	$222.00

2.

	Chain Store	Small Pharmacies	Health Clubs
Price per case	$200.00	$232.00	$250.00
Less: Cost per case	178.40	208.52	222.00
Profit per case	$ 21.60	$ 23.48	$ 28.00
Profit percent per case	10.80%	10.12%	11.20%

The profit percentages range from 10.12 percent to 11.20 percent. There appears to be cost justification for the price differentials among the three customer classes.

3. The average price per case is $227.33. If this price were charged to all three customers, the profit percentage for the chain store would increase and the profit percentages to the small pharmacies and health clubs would decrease. While Cobalt would earn the same overall profit percentage, this assumes that the chain store would continue to purchase the vitamin supplements from Cobalt at the new higher price. This assumption may be wrong. The chain store may well refuse to buy any product from Cobalt, leaving Cobalt with fewer units sold overall and a lower profit from the remaining customers.

Cornerstone 12-2 shows that price differences must be linked to cost differences. When this is done, the company's contention that higher prices are related to higher costs may shield it from charges of price discrimination and may also act as a behavioural prod to more expensive customers to change their way of doing business to qualify for price breaks.

ETHICS Just as a company can practise unethical behaviour in applying costs, it can mislead in pricing. A good example is the practice some airlines have of adding on fees outside of advertised prices. According to an article from May 31, 2011, in *The Wall Street Journal*, airline revenue from add-ons to ticket sales jumped to almost $22 billion last year and continues to soar as more carriers chase extra sources of income. A growing number of carriers worldwide are charging passengers for services once included in ticket prices, such as baggage and meals. Carriers are also finding new revenue sources, such as in-flight Internet connections. Forty-seven of the world's largest airlines, which together account for almost half of all airline revenue, last year reported ancillary sales of 15.11 billion euros, up 38 percent from 2009. Other carriers surveyed did not specify how much passenger revenue they receive from sources other than fares.

No-frills budget carriers began charging for extras more than a decade ago, when the rise of Internet ticket sales allowed them to split out elements more easily and charge passengers directly. They attract fliers with bargain ticket prices and earn more than 20 percent of their total revenue from ancillary sources. But more traditional carriers are expanding quickly, especially because fuel prices have risen significantly over recent years and airlines have not been able to raise fares.

In 2007, only 23 airlines reported ancillary revenues and the total was less than $2.5 billion, according to the article.[4] For example, reserving seats prior to 24 hours before flight time costs up to $15 extra and must be paid with a second credit-card charge. This is not illegal since passengers are not required to reserve seats. However, some customers have found the practice misleading.[5]◆

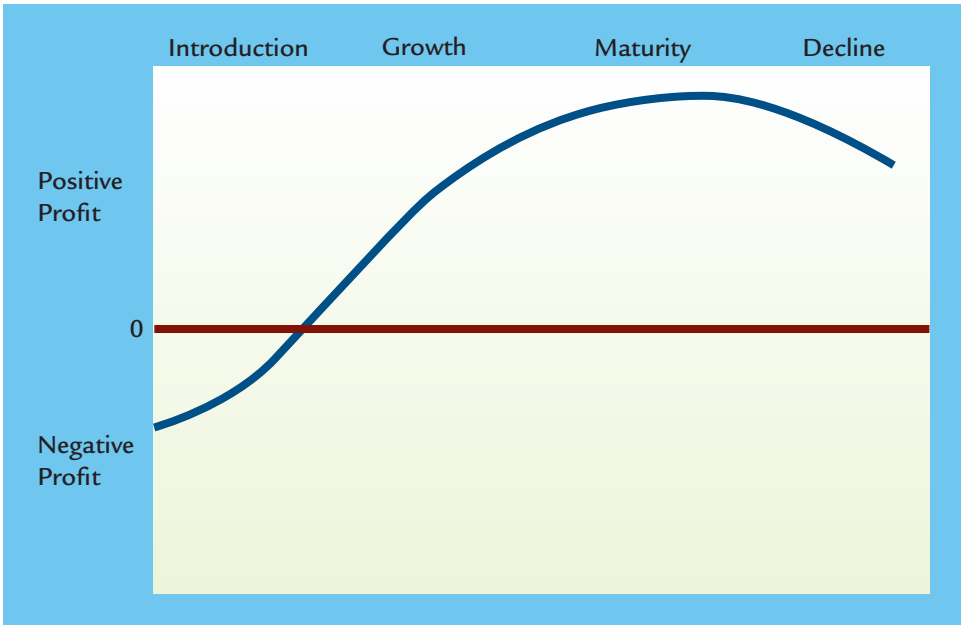
The Product Life Cycle

OBJECTIVE 4
Discuss the variations in price, cost, and profit over the product life cycle.

There are a number of views of the product life cycle. Many products have a predictable profit or product life cycle. From the perspective of marketing, the **product life cycle** describes the profit history of the product according to four stages: introduction, growth, maturity, and decline. In the introductory phase, profits are low for two reasons. First, revenues are low as the product gains market acceptance. Second, investment and learning may be high, leading to higher expenses. The growth stage is characterized by increasing market acceptance and sales, as well as economies of scale, which bring down expenses. The product breaks even, and profit rises. In the maturity phase, profits stabilize. The product has found its market, and revenues are relatively stable. Investment is down, and all learning effects in production are realized, leading to stable costs. Finally, in the decline phase, the product reaches the end of its cycle, and revenues and profits decline. Costs may still be low, but not enough to slip in below sales. Exhibit 12-2 illustrates the interaction of profit and the product life cycle with its four stages.

Exhibit 12-2

Product Life Cycle and Profitability



[4] Daniel Michaels, "Extra Airline Fees & Growth Market," *The Wall Street Journal* (May 31, 2011).
[5] Scott McCartney, "The Next Airline Fee: Buying Tickets?" *The Wall Street Journal* (March 3, 2009): D4.

The product life cycle helps the firm understand the different competitive pressures on a product in each stage. Thus, it is important for planning purposes. The regularities in manufacturing, costs, and profit make the product life cycle just as important in cost management. Each stage of the product life cycle demonstrates a fairly predictable impact on various types of costs. Exhibit 12-3 summarizes these effects.

How long is the product life cycle? That depends on the product and the environment that the product faces. Television took years to reach maturity, partially due to its introduction during the Second World War, when necessary technical assets were diverted to the war effort. Video games typically reach maturity very quickly—in a matter of months. Fad products, such as Sourballs, may zip through the product life cycle in a matter of weeks.

Knowledge of the product life cycle is important for cost management. We can easily see the impact of the four stages on marketing and the growth and decline of sales. Less obvious is the impact on the cost side. Manufacturing must be aware of the impact of newness on costs. Any time a new product is introduced, there are learning effects. In other words, as a company makes more of the product, the employees become better at making it. Purchasing locates and becomes familiar with suppliers of the needed materials. Manufacturing learns to set up more quickly and efficiently the equipment for a new batch. The industrial engineers are able to "work the bugs out" of the process. The whole production process smooths out and becomes faster and more efficient—and less expensive. However, that is not the whole story. As we can see in Exhibit 12-3, the maturity phase is marked by extensive product differentiation as line extensions proliferate.

Mattel's Barbie is over 50 years old—but we're not just talking basic Barbie anymore. Barbie has changed. Her arms and legs are bendable, and her hair is any number of lengths and colours. She has a dizzying array of outfits and accessories. Each version requires different materials and setups. In addition, Barbie has lots of friends—each with different production requirements. In 2008, Barbie, her friends, and various vehicles, houses, and so on, brought in over $1.2 billion in revenue for Mattel. With each decade's new cohort of little girls, Barbie and friends may be in the maturity phase for quite some time to come.[6]

Exhibit 12-3

Impact of the Product Life Cycle on Cost Management

	Introduction	Growth	Maturity	Decline
Product	Basic design, few models	Some improvements, expanding product line	Proliferation of product lines, extensive differentiation	Minimal changes, reduced number of product lines
Learning effects	High costs, much learning, but little payoff	Still strong, learning begins to reduce costs	Stable production, little to no learning	No learning, labour as efficient as it can be
Setups	Few, but new and unfamiliar	More, as new models are introduced	Many, as product differentiation occurs	Fewer, as only best selling lines are produced
Purchasing	May be high as new materials and suppliers are sought	Lower, reliable suppliers found, few material changes	May be high depending on line changes	Fewer suppliers and orders as existing inventories are liquidated
Marketing expense	Low selling and distribution costs to small number of target markets	Increased advertising and distribution	Supportive advertising, increased trade discounts, high distribution cost	Minimal advertising, distribution, and promotion

[6] Karen Sprey, "Happy Birthday, Barbie," *Business Week* (March 17, 2009), http://www.businessweek.com/lifestyle/content/mar2009/bw20090317_261333.htm.

The product life cycle has implications for activity-based costing. Recall that ABC categories are unit level, batch level, product level, and facility level. Unit-level costs are highest in the introduction phase, as new materials are sought in small order quantities. In addition, direct labour is higher per unit as labour learns how to manufacture the new item. Unit-level costs begin to fall in the growth phase as learning takes effect and quantity discounts on materials may occur. Similarly, the maturity phase should lead to stable unit-level costs. The decline phase, with fewer units produced, does not enjoy quantity discounts, but unit costs may remain low due to the liquidation of existing inventories and the avoidance of increasing prices.

Batch-level costs follow a similar pattern. Purchasing, receiving, setups, and inspection are high in the introductory phase due to unfamiliarity. In the growth phase, batch-level costs should decrease as the positive impact of learning occurs. Workers are better able to execute setups, for example. In the maturity phase, batch-level costs may increase as product differentiation occurs. Setup number and complexity increase, purchasing orders rise, and inspection costs may increase. Finally, in the decline stage, batch-level costs again fall as product lines are streamlined to just a few best-selling lines and batches decrease in number and complexity.

Product-level costs are highest in the introductory phase and generally fall throughout the rest of the life cycle—with possible spikes upward for new models in the maturity phase. An example is engineering change orders, which occur most frequently when the product is started into production. Facility-level costs may or may not be affected unless the product calls for a new facility or equipment—then they are highest in the introductory phase. Exhibit 12-4 depicts the general direction of costs in the ABC categories throughout the product life cycle.

Measuring Profit

OBJECTIVE 5

Explain why firms measure profit, and calculate measures of profit using absorption and variable costing.

Profit is a measure of the difference between what a firm puts into making and selling a product or service and what it receives. There are a number of definitions of profit. Some are used for external reporting and some for internal reporting.

Reasons for Measuring Profit

Clearly, firms are interested in measuring profit. In fact, firms are classified according to whether or not profit is the primary objective—they are either for-profit or not-for-profit entities. Profits are measured for a number of reasons. These include determining the viability of the firm, measuring managerial performance, determining whether or not a firm adheres to government regulations, and signalling the market about the opportunities for others to earn a profit.

Owners of a company want to know if the company is viable in both the short term and the long term. Work gives meaning to life. Staying in business is not only a means to an end but an end in itself.

Profit can be used to measure managerial performance. Assessing performance is complicated, but profit, because it is measured in dollars, simplifies scorekeeping. Top

Exhibit 12-4

Product Life-Cycle Costs in the ABC Categories

	Product Life-Cycle Phase			
ABC Category	**Introduction**	**Growth**	**Maturity**	**Decline**
Unit-level costs	High	Lower	Low to stable	Low
Batch-level costs	High	Lower	Higher	Low
Product-level costs	High	Lower	Low to stable	Low
Facility-level costs	High	Low	Low	Low

management is usually evaluated on the basis of profit and/or return on investment. Both measures require benefits to exceed costs.

Regulated firms must keep profits within certain limits. The profitability of a regulated monopoly is monitored to ensure that the public is served by this structure and that prices do not escalate to the level of an unregulated monopoly. Note that price alone is not set—instead, the price must be set to ensure a "reasonable rate of return," and it is tied to the costs incurred by the regulated firm. Examples of companies subject to regulation are utilities, local telephone companies, and cable television companies. These companies enjoy monopoly status, and they pay for the privilege through adherence to regulations.

Profit also signals others outside a company of potential opportunities. A highly profitable firm signals the market that others might also benefit from entry. Low profits do not entice competition. For this reason, companies may deliberately avoid high short-term profits.

For example, in the 1940s, **DuPont** marketed nylon to manufacturers of women's hosiery and lingerie at a price that was only 60 percent of what could have been charged—despite the fact that nylon was patented and there was virtually no competition. As a result, competition was delayed for five to six years, and the overall market for nylon expanded dramatically into unanticipated areas, such as its use in automobile tires.[7]

Even though a not-for-profit entity has no profit, it still is engaged in an exchange relationship and must assess its performance and long-term viability. Donors want information on charities. Corporate donors, in particular, want better measures of how well a charity fulfills its mission, and how well it uses and accounts for resources. Supplies, postage, telephones, and office space all require money. Employee wages are not necessarily below the market wage; they simply have no claim to any residual. As a result, many of the concepts covered in this chapter have relevance to not-for-profit entities. The **Girl Guides of Canada**, for example, expect to profit from cookie sales, although they may not refer to the money made above cost as profit. Not-for-profit firms are still interested in the relationship between revenues and expenses, or inflows and outflows.

Absorption-Costing Approach to Measuring Profit

Absorption costing, or full costing, is required for external financial reporting. According to GAAP, profit is a long-run concept and depends on the difference between revenues and expenses. Over the long run, of course, all costs are variable. Therefore, fixed costs are treated as if they were variable by assigning some to each unit of production. **Absorption costing** assigns all manufacturing costs, direct materials, direct labour, variable overhead, and a share of fixed overhead, to each unit of product. In this way, each unit of product absorbs some of the fixed manufacturing overhead in addition to its variable manufacturing costs. When a unit of product is finished, it takes these costs into inventory with it. When it is sold, these manufacturing costs are shown on the income statement as cost of goods sold. It is absorption costing that is used to calculate three measures of profit: gross profit, operating income, and net income. Cornerstone 12-3 shows the how and why of calculating the cost of inventory and preparing the income statement under absorption costing.

The income statement shown in Cornerstone 12-3 is the familiar full costing income statement used for external reporting. Recall that the difference between revenue and cost of goods sold is gross profit (or gross margin). This is not equal to operating income, because the marketing and administrative expenses remain to be covered. At one time, gross profit was a fairly useful measure of profitability. Marketing and administrative expenses were relatively stable and could be adjusted fairly easily. In today's economic environment, that is less true. Government regulations affect businesses in sometimes unforeseen ways. Regulations relating to wheelchair accessibity

[7] Drucker, "The Five Deadly Business Sins."

The HOW and WHY of Calculating Inventory Cost and Preparing the Income Statement Using Absorption Costing

CORNERSTONE 12-3

Information:

Lasersave Inc. a recycler of used toner cartridges for laser printers, began operations in August and manufactured 1,000 cartridges during the month with the following unit costs:

Direct materials	$ 5.00
Direct labour	15.00
Variable overhead	3.00
Fixed overhead*	20.00
Variable marketing cost	1.25

*Fixed overhead per unit = $20,000/1,000 units produced = $20

Total fixed factory overhead is $20,000 per month. During August, 1,000 cartridges were sold at a price of $60, and fixed marketing and administrative expenses were $12,000.

Why:

Firms use absorption costing to value inventory and to calculate cost of goods sold for the income statement. This use is acceptable according to GAAP. It ensures that in the long run, all manufacturing costs are absorbed by the units produced.

Required:

1. Calculate the unit cost of each toner cartridge using absorption costing.
2. How many units remain in ending inventory? What is the cost of ending inventory using absorption costing?
3. Prepare an absorption-costing income statement for Lasersave Inc. for the month of August.
4. ***What if*** September production was 1,250 units, costs were stable, and sales were 1,000 units? What is the cost of ending inventory? What is operating income for September?

Solution:

1. The unit product (manufacturing) cost under absorption costing is:

Direct materials	$ 5.00
Direct labour	15.00
Variable overhead	3.00
Fixed overhead	20.00
Total cost	$43.00

2. Units in ending inventory = Units, beginning inventory + Units produced − Units sold = 0 + 1,000 − 1,000 = 0 units

   Cost of ending inventory = $0

CORNERSTONE 12-3 *(continued)*

3.

Lasersave Inc.
Absorption-Costing Income Statement
For the Month of August

		Percent of Sales
Sales ($60 × 1,000)	$ 60,000	100.00%
Less: Cost of goods sold ($43 × 1,000)	43,000	71.67
Gross profit	17,000	28.33%
Less:		
Variable marketing expenses ($1.25 × 1,000)	(1,250)	(2.08)
Fixed marketing and administrative expenses	(12,000)	(20.00)
Operating income	$ 3,750	6.25%

4. Units in ending inventory = Units, beginning inventory + Units produced − Units sold = 0 + 1,250 − 1,000 = 250 units

Cost of ending inventory = $39 × 250 = $9,750

The new operating income is $7,750, calculated as follows:

Sales ($60 × 1,000)	$ 60,000
Less: Cost of goods sold ($39* × 1,000)	39,000
Gross profit	21,000
Less:	
Variable marketing expenses ($1.25 × 1,000)	(1,250)
Fixed marketing and administrative expenses	(12,000)
Operating income	$ 7,750

*Fixed manufacturing cost/Units manufactured = $20,000/1,250 = $16; therefore, unit product cost = $5 + $15 + $3 + $16 = $39

and environmental cleanup are just two examples of government actions that increase nonmanufacturing expenses. Additionally, research and development, also an expense subtracted from gross profit to yield operating income, is increasingly important. Now, gross profit is less useful and cannot be used as a sole measure of the long-run health of the firm.

The income statement in Cornerstone 12-3 also shows the "Percent of Sales" column, which is often associated with the absorption-costing income statement. Notice that Lasersave Inc. earned a gross profit of just over 28 percent of sales, and that operating income was 6.25 percent of sales. Is this good or bad performance? It depends on the typical experience for the industry. If most firms in the industry earned a gross margin of 35 percent of sales, Lasersave would be considered below average, and it might look for opportunities to decrease cost of goods sold or to increase revenue.

What about absorption-costing operating income? Is it a reasonable measure of performance? Problems exist with this measure, too. First, managers can remove some current-period costs from the income statement by producing for inventory. Second, the absorption-costing format is not useful for decision making.

Disadvantages of Absorption Costing In general, a company manufactures a product in order to sell it. In fact, that was the case for Lasersave for the

month of August when every unit produced was sold. September is a different story. Lasersave produced 1,250 units but sold only 1,000. The price, variable cost per unit, and total fixed costs remain the same. Cornerstone 12-3 shows that even though September sales were the same as August sales, and costs remained stable, September operating income was higher than August operating income.

Operating income in September is $7,750 versus operating income for August of $3,750. The same number of units was sold, at the same price, and the same costs. What happened? The culprit is treating fixed manufacturing overhead as if it were variable. In August, 1,000 units were produced, and each one absorbed $20 ($20,000/1,000 units produced) of fixed overhead. In September, however, the same total fixed manufacturing overhead of $20,000 was spread out over 1,250 units, so each unit absorbed only $16 ($20,000/1,250). The 250 units that went into ending inventory took with them all of their variable costs of production of $5,750 ($23 × 250) plus $4,000 (250 × $16) of fixed manufacturing overhead from September. That $4,000 of inventoried fixed manufacturing overhead is precisely equal to the $4,000 difference in operating incomes.

Clearly, the absorption-costing income statement gives the wrong message in September. It seems to say that September performance was better than August performance, when the sales performance was identical and, arguably, production was off by 250 units. (Even if the company wanted to produce for inventory, it is misleading to increase income for the period as a result.)

Of course, the whole purpose of manipulating income by producing for inventory is to increase profit above what it would have been without the extra production. Managers who are evaluated on the basis of operating income know that they can temporarily improve profitability by increasing production. They may do this to ensure year-end bonuses or promotions. As a result, the usefulness of operating or net income as a measure of profitability is weakened. This is a major disadvantage of absorption costing. Companies that use absorption-costing income as a measure of profitability may institute rules regarding production. For example, a manufacturer of floor care products insists that the factory produce only the amounts called for in the master budget. While this will not erase the impact of changes in inventory on operating income, it does mean that the factory manager cannot deliberately manipulate production to increase income.

The second disadvantage of absorption costing is that it is not a useful format for decision making. Suppose that Lasersave was considering accepting a special order for 100 toner cartridges at $38. Should the company accept? If we focus on the absorption-costing income statement, who can tell? In August, the manufacturing cost per unit was $43. In September, it was $39. Neither figure included the marketing cost. The treatment of fixed overhead as a unit-level variable cost has made it difficult to see just what the incremental cost is.

Variable-Costing Approach to Measuring Profit

An approach to measuring profitability that avoids the problems inherent in making fixed overhead a variable cost is variable costing. **Variable costing** (sometimes called direct costing) assigns only unit-level variable manufacturing costs to the product; these costs include direct materials, direct labour, and variable overhead. Fixed overhead is treated as a period cost and is not inventoried with the other product costs. Instead, it is expensed in the period incurred.

The result of treating fixed manufacturing overhead as a period expense is to reduce the factory costs that are inventoriable. Under variable costing, only direct materials, direct labour, and variable overhead are inventoried. (Remember that marketing and administrative expenses are never inventoried—whether variable or fixed.) Therefore, the inventoriable variable product cost for Lasersave is $23 ($5 direct materials + $15 direct labour + $3 variable overhead).

The variable-costing income statement is set up a little differently from the absorption-costing income statement. Cornerstone 12-4 shows the how and why of

CORNERSTONE 12-4

The HOW and WHY of Calculating Inventory Cost and Preparing the Income Statement Using Variable Costing

Information:

Lasersave Inc. a recycler of used toner cartridges for laser printers, began operations in August and manufactured 1,000 cartridges during the month with the following unit costs:

Direct materials	$ 5.00
Direct labour	15.00
Variable overhead	3.00
Fixed overhead*	20.00
Variable marketing cost	1.25

*Fixed overhead per unit = $20,000/1,000 units produced = $20

Total fixed factory overhead is $20,000 per month. During August, 1,000 cartridges were sold at a price of $60, and fixed marketing and administrative expenses were $12,000.

Why:

Firms use variable costing to value inventory and to calculate cost of goods sold for the income statement for internal management decision making. Variable costing is not acceptable according to GAAP. However, it is a useful format for decision making and does not allow managers to manipulate income by producing for inventory.

Required:

1. Calculate the unit cost of each toner cartridge using variable costing.
2. How many units remain in ending inventory? What is the cost of ending inventory using variable costing?
3. Prepare a variable-costing income statement for Lasersave Inc. for the month of August.
4. ***What if*** September production was 1,250 units, costs were stable, and sales were 1,000 units? What is the cost of ending inventory? What is operating income for September?

Solution:

1. The unit product (manufacturing) cost under variable costing is:

Direct materials	$ 5.00
Direct labour	15.00
Variable overhead	3.00
Total cost	$23.00

2. Units in ending inventory = Units, beginning inventory + Units produced − Units sold = 0 + 1,000 − 1,000 = 0 units

   Cost of ending inventory = $0

CORNERSTONE 12-4 *(continued)*

3.

Lasersave Inc.
Variable-Costing Income Statement
For the Month of August

		Percent of Sales
Sales ($60 × 1,000)	$ 60,000	100.00%
Less:		
Variable cost of goods sold ($23 × 1,000)	(23,000)	(38.33)
Variable marketing expense ($1.25 × 1,000)	(1,250)	(2.08)
Contribution margin	35,750	59.58%
Less:		
Fixed factory overhead	(20,000)	(33.33)
Fixed marketing and administrative expenses	(12,000)	(20.00)
Operating income	$ 3,750	6.25%*

*Percent totals may not equal due to rounding.

4. Units in ending inventory = Units, beginning inventory + Units produced − Units sold = 0 + 1,250 − 1,000 = 250 units

Cost of ending inventory = $23 × 250 = $5,750

The new operating income is $3,750, calculated as follows:

Sales ($60 × 1,000)	$ 60,000
Less:	
Variable cost of goods sold ($23 × 1,000)	(23,000)
Variable marketing expense ($1.25 × 1,000)	(1,250)
Contribution margin	35,750
Less:	
Fixed factory overhead	(20,000)
Fixed marketing and administrative expenses	(12,000)
Operating income	$ 3,750

calculating the variable cost of inventory and preparing the variable-costing income statements for August and September.

As Cornerstone 12-4 shows, all unit-level variable costs (including variable manufacturing and variable marketing expenses) are summed and subtracted from sales to yield contribution margin. Then, all fixed expenses for the period, whether they are incurred by the factory or by marketing and administration, are subtracted to yield operating income.

Notice that the August and September variable-costing income statements for Lasersave are identical. This seems right. Each month had identical sales and costs. While September production was higher, those figures will show up as an increase in inventory on the balance sheet. As we can see, variable-costing operating income cannot be manipulated through overproduction, since fixed manufacturing overhead is not carried into inventory.

Let's take a closer look at each month. In August, production exactly equalled sales. In this case, none of the period's costs go into inventory, and absorption-costing

operating income is equal to variable-costing income. In September, inventory increased, and absorption-costing operating income is higher than variable-costing operating income. The difference of $4,000 ($7,750 − $3,750), is just equal to the fixed overhead per unit multiplied by the increase in inventory ($16 × 250 units).

What happens when inventory decreases? Again, there is an effect on operating income under absorption costing but not under variable costing. Let's take Lasersave into the month of October, when production is 1,250 units (just like September), but 1,300 units are sold.

In this case, when inventory decreases (or production is less than sales), variable-costing operating income is greater than absorption-costing operating income. The difference of $800 ($14,475 − $13,675) is equal to the 50 units that, under absorption costing, came from inventory with $16 of the previous month's fixed manufacturing overhead attached. Exhibit 12-5 summarizes the impact of changes in inventory on operating income under absorption costing and variable costing.

To summarize, when inventories change from the beginning to the end of the period, the two costing approaches will give different operating incomes. The reason for this is that absorption costing assigns fixed manufacturing overhead to units produced. If those units are sold, the fixed overhead appears on the income statement under cost of goods sold. If the units are not sold, the fixed overhead goes into inventory. Under variable costing, however, all fixed overhead for the period is expensed. As a result, absorption costing allows managers to manipulate operating income by producing for inventory.

The variable-costing income statement has an advantage in addition to providing better signals regarding performance. It also provides more useful information for management decision making. For example, how much more will Lasersave earn if it sells one more unit? Cornerstone 12-3 indicates that $17 ($60 − $43) is the per-unit gross profit. However, that figure includes some fixed overhead, and fixed overhead will not change if another unit is produced and sold. The variable-costing income statement in Cornerstone 12-4 gives more useful information. Additional contribution margin of the extra unit is $35.75 ($60 − $23 − $1.25). The key insight of variable costing is that fixed expenses do not change as units produced and sold change. Therefore, while the variable-costing income statement cannot be used for external reporting, it is a valuable tool for some management decisions.

Profitability of Segments and Divisions

Companies often want to know the profitability of a segment of the business. That segment could be a product, division, sales territory, or customer group. Determining the profit attributable to subdivisions of the company is harder than determining overall profit because of the need to allocate expenses. Segmented income statements using variable, absorption, and activity-based costing have been covered in previous chapters. For example, segmented income statements in the keep-or-drop decision were covered in Chapter 11. Activity-based segmented income statements by product line or customer class are covered in Chapters 6 and 14. As a result, we will not go into the computations in depth here. Instead, we will focus on the managerial use of variable-costing segmented income statements.

Exhibit 12-5

Changes in Inventory under Absorption and Variable Costing

If	Then
1. Production > Sales	Absorption-costing income > Variable-costing income
2. Production < Sales	Absorption-costing income < Variable-costing income
3. Production = Sales	Absorption-costing income = Variable-costing income

Profit by Product Line It is easy to understand why a firm would like to know whether or not a particular product is profitable. A product that consistently loses money and has no potential to become profitable could be dropped. This would free up resources for a product with higher potential. On the other hand, a profitable product may merit additional time and attention.

Product line profitability would be easy to compute if all costs and revenues were easily traceable to each product. This is seldom the case. Therefore, companies must first determine how profit will be computed. Let's examine Chang Company, which manufactures two products: basic fax machines and multi-function fax machines. The basic fax machine has telephone and fax capability. This type of machine is less expensive and easier to produce. The multi-function fax machine is the high-end machine. It is a combination of two-line telephone, fax, computer printer, and copier. The multi-function fax machine uses more advanced technology and is more difficult to produce. Data on each product follow.

	Basic	Multi-Function
Number of units	20,000	10,000
Direct labour hours	40,000	15,000
Price	$200	$350
Prime cost per unit	$55	$95
Overhead per unit*	$30	$22.50

*Annual overhead is $825,000, and overhead is applied on the basis of direct labour hours.

Marketing expenses, all variable, amount to 10 percent of sales. Administrative expenses of $2 million, all fixed, are allocated to the products in accordance with revenue. Absorption-costing income by product line is shown in Exhibit 12-6.

Clearly, the multi-function fax machine is more profitable. But what does this tell us? Can we conclude that each basic fax machine sold adds $41.65 ($833,000/20,000 units) to profit? Does each multi-function fax machine sold add $104.20 ($1,042,000/10,000) to profit? No, Chang Company has intermingled variable and fixed costs and has allocated administrative expenses on the basis of revenue, when there is no reason to believe that revenue drives administrative expenses. Additionally, overhead has been assigned to the products on a per-unit basis, but we do not know just what it includes. Is $22.50 an accurate representation of the overhead resources required to produce one multi-function fax machine? A variable-costing segmented income statement will give better information.

Using Variable Costing to Measure Segment Profit Chang Company could use variable costing and segregate direct fixed and common fixed expenses as well. To apply variable costing to Chang Company, we need additional information on fixed and variable costs of overhead. Suppose that total variable overhead is $360,000 and total fixed overhead is $465,000. Since overhead is applied on the basis of direct labour hours, the variable overhead assigned to basic fax machines is $261,818 [$360,000 × (40,000/55,000)]. The variable overhead assigned to multi-function

Exhibit 12-6

Chang Company Absorption-Costing Income Statement (In thousands of dollars)

	Basic	Multi-Function	Total
Sales	$ 4,000	$3,500	$ 7,500
Less: Cost of goods sold	1,700	1,175	2,875
Gross profit	2,300	2,325	4,625
Less:			
Marketing expenses	(400)	(350)	(750)
Administrative expenses	(1,067)	(933)	(2,000)
Operating income	$ 833	$1,042	$ 1,875

Exhibit 12-7

Chang Company Variable-Costing Income Statement (In thousands of dollars)

	Basic	Multi-Function	Total
Sales	$ 4,000	$ 3,500	$ 7,500
Less:			
Variable cost of goods sold	(1,362)	(1,048)	(2,410)
Sales commissions	(400)	(350)	(750)
Contribution margin	$ 2,238	$ 2,102	4,340
Less:			
Fixed overhead			(465)
Administrative expenses			(2,000)
Operating income			$ 1,875

fax machines is $98,182 [$360,000 × (15,000/55,000)]. The variable-costing income statement is given in Exhibit 12-7. Notice that all fixed expenses that are not attributable to either of the product lines are subtracted from the total column.

Divisional Profit Just as companies want to know the relative profitability of different products, they may want to assess the relative profitability of different divisions of the company. Divisional profit is often used in evaluating the performance of managers. Failure to earn a profit can lead to the division's closing. For example, **General Motors** decided to drop the Oldsmobile line due to its continued unprofitability.

Divisional profit may be calculated using any of three approaches described in the preceding section. Usually, the absorption-based approach is used, and a share of corporate expense is allocated to each division to remind them that all expenses of the company must be covered. Suppose that Polyglyph Inc. is a conglomerate with four divisions: Alpha, Beta, Gamma, and Delta. Corporate expenses of $10 million are allocated to each division on the basis of sales. The divisional income statements are as follows:

	Alpha	Beta	Gamma	Delta	Total
Sales	$ 90	$ 60	$ 30	$120	$300
Less: Cost of goods sold	35	20	11	98	164
Gross profit	55	40	19	22	136
Less:					
Division expenses	(20)	(10)	(15)	(20)	(65)
Corporate expenses	(3)	(2)	(1)	(4)	(10)
Operating income (loss)	$ 32	$ 28	$ 3	$ (2)	$ 61

How might Polyglyph view these results? Clearly, Delta has an operating loss. Corporate management would raise questions about Delta's continuing viability. However, notice that Delta's operating loss would be eliminated if allocated corporate expenses were not included. In fact, all divisions would look more profitable if corporate expenses were not allocated to the divisions. As a result, management might concentrate on Delta's potential for an improved profit picture. Delta's divisional expenses are relatively high. Perhaps this is due to an ambitious research and development program. If payoffs from this program can be anticipated, corporate management will be much less concerned than if the divisional expenses do not have potential. Corporate management will also be concerned with trends over time and the immediate and long-term prospects for each division. Even a seemingly profitable division, like Alpha, may need attention if it is in a declining industry or if it uses significantly more resources than indicated by the corporate expense allocation. Additional material on divisional profitability and responsibility accounting is covered in Chapter 10.

Overall Profit The computation of segmented profit is clearly useful in many management decisions. However, the allocation problems inherent in computing profit on divisions, segments, and product lines may mean that overall profit is most useful in some contexts. It is certainly easiest to compute, and it does have meaning. If the overall profit is consistently positive, the company remains in business, even if one or more segments is losing money.

Analysis of Profit-Related Variances

OBJECTIVE 6
Compute the sales price, price volume, contribution margin, contribution margin volume, sales mix, market share, and market size variances.

Managers frequently want to compare actual profit earned with expected profit. This leads naturally to variance analysis, in which actual and budgeted amounts are compared. Profit variances centre on the difference between budgeted and actual prices, volumes, and contribution margin.

Sales Price and Price Volume Variances

Actual revenue may differ from expected revenue because actual price differs from expected price or because quantity sold differs from expected quantity sold, or both. The **sales price variance** is the difference between actual price and expected price multiplied by the actual quantity or volume sold. In equation form, it is the following:

$$\text{Sales price variance} = (\text{Actual price} - \text{Expected price}) \times \text{Quantity sold}$$

The **price volume variance** is the difference between actual volume sold and expected volume sold multiplied by the expected price. It can be expressed in the following equation:

$$\text{Price volume variance} = (\text{Actual volume} - \text{Expected volume}) \times \text{Expected price}$$

The overall sales variance is the sum of the sales price variance and the price volume variance.

$$\text{Overall sales variance} = \text{Sales price variance} + \text{Price volume variance}$$

As is the case with all variances, the sales price and price volume variances are labelled favourable (F) if the variance increases profit above the amount expected. They are labelled unfavourable (U) if the variance decreases profit below the amount expected. Cornerstone 12-5 shows the how and why of calculating the sales price, price volume, and overall sales variances.

As is shown in Cornerstone 12-5, the sum of the sales price and price volume variances is the **total (overall) sales variance**. Of course, this is simply the difference between actual and expected revenue. Breaking the overall sales variance into price and volume components gives managers a better feel for why actual revenue may differ from budgeted revenue.

It is important to note that these variances just begin to alert managers to problems in pricing and sales. As is the case with all variances, significant variances are investigated to discover the underlying reasons for the difference between expected and actual results. In the case of an unfavourable sales price variance, the reason may be the giving of unanticipated price discounts, perhaps to meet competitors' prices. The sales price and price volume variances interact. For example, an unfavourable sales price variance may be paired with a favourable price volume variance because the lower price raised quantity sold.

Contribution Margin Variance

We have just looked at the price and sales variances. The cost variances were covered in Chapter 9. Now it is time to put sales and cost together and calculate any variances between actual and expected contribution margin. The **contribution margin variance** is the difference between actual and budgeted contribution margin.

$$\text{Contribution margin variance} = \text{Actual contribution margin} - \text{Budgeted contribution margin}$$

CORNERSTONE 12-5

The HOW and WHY of Calculating the Sales Price Variance, the Price Volume Variance, and the Overall Sales Variance

Information:

Armada Company distributes produce. In May, Armada Company expects to sell 20,000 kilograms of produce at an average price of $0.20 per kilogram. Actual results are 23,000 kilograms sold at an average price of $0.19 per kilogram.

Why:

The sales price variance tells managers what impact a difference between actual and expected sales price has on revenue. The price volume variance tells managers what impact a difference between actual and expected units sold has on revenue.

Required:

1. Calculate the sales price variance for May.
2. Calculate the price volume variance for May.
3. Calculate the overall sales variance for May. Explain why it is favourable or unfavourable.
4. ***What if*** May sales were actually 19,000 kilograms? How would that affect the sales price variance? The price volume variance? The overall sales variance?

Solution:

1. Sales price variance = (Actual price − Expected price) × Quantity sold
   = [($0.19 − $0.20) × 23,000] = $230 U
2. Price volume variance = (Actual volume − Expected volume) × Expected price
   = [(23,000 − 20,000) × $0.20] = $600 F
3. Overall sales variance = Sales price variance + Price volume variance
   = $230 U + $600 F = $370 F

   The overall sales variance is favourable because the favourable price volume variance is larger than the unfavourable sales price variance. That is, the lower than expected sales price did reduce revenue; however, the greater than expected volume overcame that effect and raised revenue overall.
4. If May sales in kilograms were 19,000, there would be a decrease in the sales price variance, since the actual number of kilograms sold decreased. There would be an unfavourable price volume variance, and the overall sales variance would be unfavourable because both the sales price variance and the price volume variance are unfavourable.

This variance is favourable if the actual contribution margin earned is higher than the budgeted amount. Cornerstone 12-6 shows the how and why of calculating the contribution margin variance.

The contribution margin variance is an overall variance. It can be broken into the contribution margin volume variance and the sales mix variance.

Contribution Margin Volume Variance The **contribution margin volume variance** is the difference between the actual quantity sold and the budgeted quantity sold multiplied by the budgeted average unit contribution margin. Note the difference between the contribution margin volume variance and the price volume variance. Both look at the difference between actual and budgeted volume sold. However, the price volume variance multiplies that difference by sales price, while the

The HOW and WHY of Calculating the Contribution Margin Variance

CORNERSTONE 12-6

Information:

Birdwell Inc. produces and sells two types of bird feeders. The regular type is a simple plastic and wood model, which can be hung from a tree branch. The deluxe model is a larger, stand-alone model, which includes a post and a round squirrel shield to prevent squirrels from eating the bird seed. Budgeted and actual data for the two models are shown below.

Budgeted Amounts:

	Regular Model	Deluxe Model	Total
Sales:			
($10 × 1,500)	$15,000		
($50 × 500)		$25,000	$40,000
Variable expenses	9,000	17,500	26,500
Contribution margin	$ 6,000	$ 7,500	$13,500

Actual Amounts:

	Regular Model	Deluxe Model	Total
Sales:			
($10 × 1,250)	$12,500		
($50 × 625)		$31,250	$43,750
Variable expenses	7,500	21,875	29,375
Contribution margin	$ 5,000	$ 9,375	$14,375

Why:

The contribution margin variance tells managers the difference between actual and expected contribution margin. This is a starting point for analyzing the factors that led to any difference between actual and expected profit.

Required:

1. Calculate the contribution margin variance.
2. ***What if*** actual units sold of the deluxe bird feeder decreased? How would that affect the contribution margin variance? What if actual units sold of the deluxe bird feeder increased? How would that affect the contribution margin variance?

Solution:

1. Contribution margin variance = Actual contribution margin
   − Expected contribution margin
   = $14,375 − $13,500 = $875 F
2. If units sold of the deluxe bird feeder decreased while everything else stayed the same, the contribution margin variance would decrease. Whether it turned unfavourable would depend on the amount of decrease in deluxe sales. On the other hand, if units sold of the deluxe bird feeder increased while everything else stayed the same, the contribution margin variance would become larger and still be favourable.

CORNERSTONE 12-7

The HOW and WHY of Calculating the Contribution Margin Volume Variance

Information:

Recall from Cornerstone 12-6 that Birdwell Inc. provided the following information:

	Budgeted	Actual
Sales in units, regular model	1,500	1,250
Sales in units, deluxe model	500	625
Total contribution margin	$13,500	$14,375

Why:

The contribution margin volume variance tells managers what impact a difference between actual and expected sales volume has on contribution margin. Unlike the price volume variance, the contribution margin variance weights the difference between actual and expected volume by the contribution margin, which includes both price and variable cost. Thus, it is more closely related to profit.

Required:

1. Calculate the budgeted average unit contribution margin.
2. Calculate the contribution margin volume variance.
3. ***What if*** actual units sold of the deluxe bird feeder decreased? How would that affect the contribution margin volume variance? What if actual units sold of the deluxe bird feeder increased? How would that affect the contribution margin volume variance?

Solution:

1. Budgeted average unit contribution margin
   = Budgeted total contribution margin/Budgeted total units
   = $13,500/(1,500 + 500) = $6.75
2. Contribution margin volume variance
   = (Actual quantity sold − Budgeted quantity sold)
   × Budgeted average unit contribution margin
   = [(1,250 + 625) − (1,500 + 500)] × $6.75 = $843.75 U
3. If actual units sold of the deluxe bird feeder decreased while everything else stayed the same, the contribution margin volume variance would decrease and become even more unfavourable. If actual units sold of the deluxe bird feeder increased while everything else stayed the same, the contribution margin volume variance would increase and become less unfavourable. Whether it turned favourable would depend on the amount of the increase in deluxe bird feeder sales.

contribution margin volume variance multiplies that difference by contribution margin. Therefore, the contribution margin volume variance gives management information about gained or lost profit due to changes in the quantity of sales.

Contribution margin volume variance = (Actual quantity sold − Budgeted quantity sold) × Budgeted average unit contribution margin

The budgeted average unit contribution margin is the total budgeted contribution margin divided by the budgeted total number of units of all products to be sold. Cornerstone 12-7 shows the how and why of calculating the contribution margin volume variance.

As Cornerstone 12-7 shows, the unfavourable contribution margin volume variance is the result of selling fewer units, in total, than budgeted. Still, we can see that Birdwell Inc. actually had a higher contribution margin than expected. The shift in the sales mix explains why.

Sales Mix Variance The sales mix represents the proportion of total sales yielded by each product. A company that produces only one product obviously has a sales mix of 100 percent for that product, and there is no effect of changing sales mix on profit. Multiproduct firms, however, do experience shifts in their sales mix. If relatively more of the high-profit product is sold, profit will be higher than expected. If the sales mix shifts toward the low-profit product, profit will be lower than expected. We can define the **sales mix variance** as the sum of the change in units for each product multiplied by the difference between the budgeted contribution margin and the budgeted average unit contribution margin.

$$\begin{aligned}\text{Sales mix variance} = {} & [(\text{Product 1 actual units} - \text{Product 1 budgeted units}) \\ & \times (\text{Product 1 budgeted contribution margin} \\ & - \text{Budgeted average unit contribution margin})] \\ & + [(\text{Product 2 actual units} - \text{Product 2 budgeted units}) \\ & \times (\text{Product 2 budgeted contribution margin} \\ & - \text{Budgeted average unit contribution margin})]\end{aligned}$$

The preceding sales mix variance equation, as detailed in Cornerstone 12-8, is for two products. If three products were produced, we would simply keep adding the change in units times the change in contribution margin for every additional product.

Now, we can see that the favourable sales mix variance of $1,718.75, combined with the unfavourable contribution margin volume variance of $843.75, explains the overall favourable contribution margin variance of $875.

Market Share and Market Size Variances

Managers not only want to look inward at contribution margin through the volume and sales mix variances, but they also want to look outward to see how their company is doing compared with the rest of their industry. **Market share** gives the proportion of industry sales accounted for by a company. **Market size** is the total revenue for the industry. Clearly, both market share and market size have an impact on a company's profits.

The **market share variance** is the difference between the actual market share percentage and the budgeted market share percentage multiplied by actual industry sales in units times budgeted average unit contribution margin. The **market size variance** is the difference between actual and budgeted industry sales in units multiplied by the budgeted market share percentage times the budgeted average unit contribution margin.

$$\begin{aligned}\text{Market share variance} = {} & [(\text{Actual market share percentage} - \text{Budgeted market share} \\ & \text{percentage}) \times \text{Actual industry sales in units}] \times \text{Budgeted} \\ & \text{average unit contribution margin} \\ \text{Market size variance} = {} & [(\text{Actual industry sales in units} - \text{Budgeted industry sales} \\ & \text{in units}) \times \text{Budgeted market share percentage}] \times \text{Budgeted} \\ & \text{average unit contribution margin}\end{aligned}$$

Cornerstone 12-9 shows the how and why of calculating the market share variance and the market size variance.

As Cornerstone 12-9 shows, the market share variance for Birdwell is $2,869 unfavourable. In other words, Birdwell's reduction in market share from 10 percent to 8.152 percent cost the company $2,869 in contribution margin.

CORNERSTONE 12-8

The HOW and WHY of Calculating the Sales Mix Variance

Information:

Recall from Cornerstone 12-6 that Birdwell Inc. provided the following information:

	Budgeted	Actual
Sales in units, regular model	1,500	1,250
Sales in units, deluxe model	500	625
Unit contribution margin, regular model	$4.00	
Unit contribution margin, deluxe model	$15.00	
Total contribution margin	$13,500	$14,375

Why:

The sales mix variance tells managers what impact a difference between actual and expected percentages of products sold has on contribution margin. Only budgeted contribution margins are used to weight the differences in the sales mix.

Required:

1. Calculate the sales mix variance.
2. ***What if*** actual units sold of the deluxe bird feeder decreased? How would that affect the sales mix variance? What if actual units sold of the deluxe bird feeder increased? How would that affect the sales mix variance?

Solution:

1. Sales mix variance = [(Product 1 actual units – Product 1 budgeted units) × (Product 1 budgeted contribution margin – Budgeted average unit contribution margin)] + [(Product 2 actual units – Product 2 budgeted units) × (Product 2 budgeted contribution margin – Budgeted average unit contribution margin)]

   $= [(1{,}250 - 1{,}500) \times (\$4.00 - \$6.75)] + [(625 - 500) \times (\$15.00 - \$6.75)$

   $= \$1{,}718.75$ F

2. If actual units sold of the deluxe bird feeder (the high contribution margin product) decreased while everything else stayed the same, the sales mix variance would decrease and become less favourable. Depending on the amount of decrease, the sales mix variance could become unfavourable. If, on the other hand, actual units sold of the deluxe bird feeder increased, then the sales mix variance would increase and become more favourable.

The impact of changing market size on Birdwell's profits can be assessed through the market size variance. It is $2,025 favourable. This means that the company's contribution margin would have increased by this amount had the actual market share percentage equalled the budgeted market share percentage. Unfortunately for Birdwell, the market share percentage slipped. Still, Birdwell is better off due to increasing market size, since a market share of 8.2 percent would yield even smaller profits from a smaller market.

While the contribution margin variances and the market share and market size variances yield important insights into profitability, companies may want to analyze profit further.

The HOW and WHY of Calculating the Market Share Variance and the Market Size Variance

CORNERSTONE 12-9

Information:

Budgeted unit sales for the entire bird feeder industry were 20,000 (of all model types), and actual unit sales for the industry were 23,000. Recall from Cornerstone 12-6 that Birdwell Inc. provided the following information:

	Budgeted	Actual
Sales in units, regular model	1,500	1,250
Sales in units, deluxe model	500	625
Total contribution margin	$13,500	
Budgeted average unit contribution margin	$6.75	

Why:

The market share and market size variances allow firms to compare their performance with the market as a whole. This gives managers a chance to look outside their own companies and to see what the possibilities are in the market for their products.

Required:

1. Calculate the market share variance.
2. Calculate the market size variance.
3. ***What if*** Birdwell actually sold a total of 2,300 units (in total of the two models)? How would that affect the market share variance? The market size variance?

Solution:

1. Market share variance = [(Actual market share percentage − Budgeted market share percentage) × Actual industry sales in units] × Budgeted average unit contribution margin
   Actual market share percentage = 1,875/23,000 = 0.08152, or 8.152% (rounded)
   $$\text{Budgeted market share percentage} = 2{,}000/20{,}000 = 0.10, \text{ or } 10\%$$
   $$\text{Market share variance} = [(0.08152 - 0.10) \times 23{,}000] \times \$6.75$$
   $$= \$2{,}869 \text{ U (rounded to the nearest dollar)}$$
   Note that the market share variance is unfavourable because Birdwell's actual share of the market is less than the budgeted share of the market.
2. Market size variance = [(Actual industry sales in units − Budgeted industry sales in units) × Budgeted market share percentage] × Budgeted average unit contribution margin
   $$= [(23{,}000 - 20{,}000) \times 0.10] \times \$6.75$$
   $$= \$2{,}025 \text{ F}$$
   Note that the market size variance is favourable because the actual units sold in the market is larger than the number of units expected to be sold in the market.
3. If Birdwell actually sold a total of 2,300 units, then the actual market share percentage would be 10 percent, exactly equal to the budgeted market share percentage. The market share variance would be zero. There would be no impact on the market size percentage.

OBJECTIVE 7
Describe some of the limitations of profit measurement.

Limitations of Profit Measurement

Profit measurement is important, but there is more to life and business than monetary profit measurement.

One limitation to profitability analysis is its focus on past, not future, performance. The economic environment is unpredictable, and consistent profitability—brought about by great management, productive employees, and a high-quality product—does not guarantee success when economic conditions change. At that point, shifts in strategy may prove crucial. For example, the shift from payment for costs incurred to payment by diagnosis code has changed life considerably in the health-care industry. Previously, insurance companies and the government paid doctors and hospitals for all costs incurred. Clearly, cost cutting was not important. Now, the emphasis on efficiency and cost control has had a significant impact on all participants in the medical field.

Johnson & Johnson, for example, worked hard to change the rate of reimbursement for stents used in angioplasty. The J&J stent was technically superior to others on the market and cost more. However, Medicare in the United States paid hospitals the same amount no matter which stent was used. J&J was able to show, using data on 200,000 Medicare patients, that patients using the J&J stent were able to avoid a second and third angioplasty. Stent reimbursement increased.[8]

The point is that companies must remain flexible and be aware of changing business conditions. The savvy cost manager is aware of economic and environmental trends outside the company. These can determine the success of management plans. They also help provide a reference point for management in determining whether profits are good or bad. A small increase in profit during a recession may signal outstanding performance. The same increase during economic expansion raises doubts about management's ability.

Another limitation is profit's emphasis on quantifiable measures. Henry Ford said that both buyer and seller must be wealthier in some way as a result of a transaction. But must wealth always be measured in money? Some aspects of profit are, no doubt, qualitative. Start-up companies may be thrilled to have made it past the one-year mark. The confidence that comes with being able to successfully start and continue a business is part of their wealth. Many companies give back a portion of their profits to their communities; this, too, is a form of wealth.

Finally, we must remember that profit has a strong impact on people's behaviour. Predictably, individuals prefer profit to loss. Their jobs, promotions, and bonuses may depend on the annual profit, and this dependence can affect their behaviour in expected and unexpected ways. As accountants, it is important to realize that profit measurement can lead to different incentives for individuals to work harder and to act ethically.

ETHICS People's desire to avoid losses and their inclination to take a short-run perspective can affect the potential for unethical conduct. Unethical conduct can take any number of forms, but basically it comes down to lying. Companies may try to pass off inferior work or materials as high-quality work—worthy of a higher price. Companies may keep two sets of books—for the purpose of cheating on income and other taxes. They may overstate the value of inventory in order to understate the cost of goods sold and thereby overstate net income.

Companies that value numerical profit above all else should not be surprised if employees act accordingly and do what is in their power to increase the numbers. Not only does this overreliance on numerical profit lead to unethical behaviour, but

[8] Ron Winslow, "Johnson & Johnson Misses Beat with Device for Cardiac Surgery," *The Wall Street Journal* (September 18, 1998): A1.

it also provides incentives to ignore the less measurable outcomes that might benefit the company. Workers basically look for companies to "put their money where their mouth is." If raises, promotions, and bonuses are awarded only on the basis of profit, employees will work to increase profits. Even if the company says other factors are important (e.g., good corporate citizenship, innovation, and high-quality products), this will be seen as mere lip service.

The ever-present salience of monthly, quarterly, and annual profit and loss statements may cause companies to emphasize short-run results. Too much emphasis on short-run optimization can lead to ethical problems. A solution is to focus on the long run. Companies that take a long-run orientation know that they cannot cheat customers and expect to retain their business. Eventually, shoddy materials and workmanship will be realized by the customer. The customer will go elsewhere, and regaining trust once lost is an agonizingly slow process. As a result, ethical people and companies often emphasize the long run as the best basis for behaviour.◆

Summary of Learning Objectives

1. Discuss basic pricing concepts.

- The basic economic interplay between demand and supply helps to set price.
  - Customers buy less at a high price than they do at a low price.
  - Producers (suppliers) are able to supply more at a high price than at a low price.
  - Equilibrium price is set where quantity demanded equals quantity supplied.
- Price elasticity of demand is the percent change in quantity demanded for a given percent change in price.
  - Products with elastic demand tend to:
    - Have many substitutes
    - Not be necessities
    - Take a relatively large amount of consumer income
  - Products with inelastic demand tend to:
- Have few substitutes
- Be necessities
- Take a relatively small amount of consumer income
- Market structure affects the relationship between the company and other companies in its industry.
  - Perfectly competitive markets have many buyers and sellers. Price is set in the market.
  - Monopolistic competition is characterized by some ability to differentiate one's product from that of other firms.
  - Monopoly is characterized by one seller with the ability to increase price somewhat above that of a competitive market. There may be legal reasons for the monopoly.
  - Oligopoly is characterized by few sellers and many buyers. There are frequently high barriers to entry in this market.

2. Calculate a markup on cost and a target cost.

- Many firms use cost-based pricing.
  - Price is based on cost plus desired profit.
  - The markup is NOT pure profit—it also includes all costs not included in the base cost.
  - Strategy is supply based—it does not take demand into account until late in the process.
- Target cost-based pricing strategy begins with price and subtracts desired profit to determine allowable cost.

3. Discuss the impact of the legal system and ethics on pricing.

- The legal system supports competition and outlaws certain business practices.
  - Predatory pricing
  - Some forms of price discrimination
- Fairness and ethical conduct may prevent the exploitation of market power.
  - Price gouging
  - Dumping

4. Discuss the variations in price, cost, and profit over the product life cycle.

- The product life cycle has an important impact on price.
  - Introduction phase usually has negative profit.
  - Growth phase shows increasing profit.
  - Maturity phase is accompanied by a levelling off of profit.
  - Decline phase is the end of the product life cycle.
- Learning effects and increasing efficiency help costs decrease as the product life cycle changes from introduction through growth and maturity.

5. Explain why firms measure profit, and calculate measures of profit using absorption and variable costing.

- Profit is measured to assess performance.
- Absorption-costing income measurement is required for external financial reporting.
  - All manufacturing costs are attached to units of product including:
    - Direct materials
    - Direct labour
    - Variable factory overhead
    - A portion of fixed factory overhead
  - Product costs for the period are assigned to units sold or units put into inventory.
- Variable costing is useful for management decision making.
  - All variable manufacturing costs are attached to units of product including:
    - Direct materials
    - Direct labour
    - Variable overhead
  - All fixed costs (including fixed factory overhead and fixed selling and administrative expense) are treated as period expenses on the income statement.
- Variable costing and ABC give better signals regarding performance and incremental costs.

- Profitability analysis can be accomplished for individual segments, including:
  - Product lines
  - Divisions
  - Customer groups

6. Compute the sales price, price volume, contribution margin, contribution margin volume, sales mix, market share, and market size variances.

- Profit-related variances are used to analyze the changes in profit from one time period to another.
  - Sales price variance compares expected price with actual price and multiplies by actual volume.
  - Price volume variance compares actual volume with expected volume and multiplies by expected price.
- Contribution margin variance considers interplay of price and variable cost.
  - Contribution margin volume variance shows the impact of a difference between expected and actual sales volume on contribution margin.
  - Sales mix variance shows the impact on contribution margin of changes in the actual versus expected sales mix.
- Market share and size variances allow a firm to compare its performance against competing firms.
  - Market share variance shows the impact of a difference between actual and expected percentage of market volume multiplied by budgeted average contribution margin.
  - Market size variance shows the impact on profit of a difference between actual volume sold in the market and expected volume.

7. Describe some of the limitations of profit measurement.

- Limitations of profit include:
  - Focus on past performance
  - Uncertain economic conditions
  - Difficulty of capturing all important factors in financial measures
- Successful firms measure far more than accounting profit.
  - Impact on the community
  - Employees
- Ethical behaviour is fostered by appropriate emphasis on profit.

CORNERSTONES FOR CHAPTER 12

CORNERSTONE 12-1 The HOW and WHY of calculating a markup on cost, page 591

CORNERSTONE 12-2 The HOW and WHY of calculating cost and profit by customer class, page 595

CORNERSTONE 12-3 The HOW and WHY of calculating inventory cost and preparing the income statement using absorption costing, page 601

CORNERSTONE 12-4 The HOW and WHY of calculating inventory cost and preparing the income statement using variable costing, page 604

Review Problems

I. Pricing

Melcher Company produces and sells small household appliances. A few years ago, it designed and developed a new hand-held mixer, named the "Mixalot." The Mixalot can be used to mix milkshakes and light batter. With the mincer attachment, it can mince up to a cup of vegetables or fruits. The Mixalot was very different from the standard table model Melcher mixer. Because of this, over $250,000 was spent on design and development. Another $50,000 was spent on consumer focus groups, in which prototypes of the Mixalot were kitchen tested by consumers. It was in those groups that safety problems surfaced. For example, one of the testers sliced his hand. This necessitated adding a plastic guard around the blade. Moulding and attaching the blade would add $1.50 to prime costs of the Mixalot, which had originally been estimated to cost $3.50 to produce. Information regarding the first five years of operations is as follows:

	Year 1	Year 2	Year 3	Year 4	Year 5
Unit sales	25,000	150,000	400,000	400,000	135,000
Price	$15	$20	$20	$18	$15
Prime cost	$125,000	$600,000	$1,640,000	$1,640,000	$526,500
Setup cost	5,000	9,600	80,000	80,000	12,000
Purchase of special equipment	65,000	—	—	—	—
Expediting	—	15,000	40,000	35,000	—
Rework	12,500	45,000	60,000	60,000	6,750
Other overhead	50,000	300,000	800,000	800,000	270,000
Warranty repair	6,250	7,500	10,000	10,000	3,375
Commissions (5%)	18,750	150,000	400,000	360,000	101,250
Advertising	250,000	150,000	100,000	100,000	25,000

During the first year, Melcher's prime costs included the safety guard. The special equipment was for moulding and attaching the guard. The equipment had a life of five years with no salvage value.

Required:

1. What is the cost of goods sold per unit for the Mixalot in each of the five years?
2. What marketing expenses were associated with the Mixalot in each of the five years? Calculate them on a per-unit basis.

3. Calculate operating income for the Mixalot in each of the five years. Then, compare all costs to revenues for the Mixalot over the entire product life cycle. Was the Mixalot profitable?
4. Discuss the pricing strategy of Melcher Company for the Mixalot, initially and over the product life cycle.

Solution:

1.

	Year 1	Year 2	Year 3	Year 4	Year 5
Prime cost	$ 125,000	$ 600,000	$1,640,000	$1,640,000	$ 526,500
Setup cost	5,000	9,600	80,000	80,000	12,000
Depreciation on special equipment	13,000	13,000	13,000	13,000	13,000
Expediting	—	15,000	40,000	35,000	—
Rework	12,500	45,000	60,000	60,000	6,750
Other overhead	50,000	300,000	800,000	800,000	270,000
Total COGS	$ 205,500	$ 982,600	$2,633,000	$2,628,000	$ 828,250
Divided by units	÷ 25,000	÷ 150,000	÷ 400,000	÷ 400,000	÷ 135,000
Unit COGS	$ 8.22	$ 6.55	$ 6.58	$ 6.57	$ 6.14

2.

	Year 1	Year 2	Year 3	Year 4	Year 5
Warranty repair	$ 6,250	$ 7,500	$ 10,000	$ 10,000	$ 3,375
Commissions (5%)	18,750	150,000	400,000	360,000	101,250
Advertising	250,000	150,000	100,000	100,000	25,000
Total marketing expenses	$275,000	$307,500	$510,000	$470,000	$ 129,625
Divided by units	÷ 25,000	÷ 150,000	÷ 400,000	÷ 400,000	÷ 135,000
Unit marketing expense	$ 11.00	$ 2.05	$ 1.28	$ 1.18	$ 0.96

3.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	$ 375,000	$3,000,000	$8,000,000	$7,200,000	$2,025,000
Less: COGS	205,500	982,600	2,633,000	2,628,000	828,250
Gross profit	169,500	2,017,400	5,367,000	4,572,000	1,196,750
Less: Marketing expenses	275,000	307,500	510,000	470,000	129,625
Operating income (loss)	$(105,500)	$1,709,900	$4,857,000	$4,102,000	$1,067,125

Five-year operating income	$11,630,525
Less: Design and development expenses	300,000
Excess of revenue over all costs	$11,330,525

Yes, the Mixalot was profitable over the five-year cycle, even after the design and development expenses were subtracted. Note that these expenses do not appear on the operating income statement required for external reporting.

4. The initial price set for the Mixalot was $15. This is the lowest price of those charged during the five-year period. It appears that Melcher Company was using a penetration pricing strategy for the Mixalot. This makes sense given that the Mixalot was not a radically new product (i.e., there were other appliances on the market that could do what the Mixalot could do). There were blenders to mix milkshakes, knives and chopping boards to cut up vegetables, and food processors to mix and chop. Melcher Company needed to get the Mixalot out into actual kitchens to build demand. Notice, too, the large marketing expenditures in the first year to create awareness. This also helps to support price increases down the line. Finally, by the

fifth year, the Mixalot is in the declining stage of the product life cycle. Probably other companies have begun producing competing products, and the number of new Mixalots demanded has declined.

II. Absorption and Variable Costing

Acme Novelty Company produces coin purses and key chains. Selected data for the past year are as follows:

	Coin Purse	Key Chain
Production (units)	100,000	200,000
Sales (units)	90,000	210,000
Selling price	$5.50	$4.50
Direct labour hours	50,000	80,000
Manufacturing costs:		
Direct materials	$ 75,000	$100,000
Direct labour	250,000	400,000
Variable overhead	20,000	24,000
Fixed overhead	50,000	80,000
Nonmanufacturing costs:		
Variable selling	30,000	60,000
Direct fixed selling	35,000	40,000
Common fixed selling*	25,000	25,000

*Common fixed selling cost totals $50,000 and is divided equally between the two products.

Budgeted fixed overhead for the year, $130,000, equalled the actual fixed overhead. Fixed overhead is assigned to products using a plantwide rate based on expected direct labour hours, which were 130,000. The company had 10,000 key chains in inventory at the beginning of the year. These key chains had the same unit cost as the key chains produced during the year.

Required:

1. Compute the unit cost for the coin purses and key chains using the variable-costing method. Compute the unit cost using absorption costing.
2. Prepare an income statement using absorption costing.
3. Prepare an income statement using variable costing.
4. Explain the reason for any difference between absorption- and variable-costing operating incomes.
5. Prepare a segmented income statement using products as segments.

Solution:

1. The unit cost for the coin purse is as follows:

Direct materials ($75,000/100,000)	$0.75
Direct labour ($250,000/100,000)	2.50
Variable overhead ($20,000/100,000)	0.20
Variable cost per unit	$3.45
Fixed overhead [(50,000 × $1.00)/100,000]	0.50
Absorption cost per unit	$3.95

The unit cost for the key chain is as follows:

Direct materials ($100,000/200,000)	$0.50
Direct labour ($400,000/200,000)	2.00
Variable overhead ($24,000/200,000)	0.12
Variable cost per unit	2.62
Fixed overhead [80,000 × $1.00)/200,000]	0.40
Absorption cost per unit	$3.02

Notice that the only difference between the two unit costs is the assignment of the fixed overhead cost. Notice also that the fixed overhead unit cost is assigned using the predetermined fixed overhead rate ($130,000/130,000 DLHrs = $1 per DLH). For example, the coin purses used 50,000 direct labour hours and so receive $1 × 50,000, or $50,000, of fixed overhead. This total, when divided by the units produced, gives the $0.50 per-unit fixed overhead cost. Finally, observe that variable nonmanufacturing costs are not part of the unit cost under variable costing. For both approaches, only manufacturing costs are used to compute the unit costs.

2. The income statement under absorption costing is as follows:

Sales [($5.50 × 90,000) + ($4.50 × 210,000)]	$1,440,000
Less: Cost of goods sold [($3.95 × 90,000) + ($3.02 × 210,000)]	989,700
Gross profit	450,300
Less: Selling expenses*	215,000
Operating income	$ 235,300

*The sum of selling expenses for both products.

3. The income statement under variable costing is as follows:

Sales [($5.50 × 90,000) + ($4.50 × 210,000)]	$1,440,000
Less:	
Variable cost of goods sold [($3.45 × 90,000) + ($2.62 × 210,000)]	(860,700)
Variable selling expenses	(90,000)
Contribution margin	489,300
Less:	
Fixed overhead	(130,000)
Fixed selling expenses	(125,000)
Operating income	$ 234,300

4. Variable-costing income is $1,000 less ($235,300 − $234,300) than absorption-costing income. This difference can be explained by the net change of fixed overhead found in inventory under absorption costing.

Coin purses:	
Units produced	100,000
Units sold	90,000
Increase in inventory	10,000
Unit fixed overhead	× $0.50
Increase in fixed overhead	$ 5,000
Key chains:	
Units produced	200,000
Units sold	210,000
Decrease in inventory	(10,000)
Unit fixed overhead	× $0.40
Decrease in fixed overhead	$ (4,000)

The net change is a $1,000 ($5,000 − $4,000) increase in fixed overhead in inventories. Thus, under absorption costing, there is a net flow of $1,000 of the current period's fixed overhead into inventory. Since variable costing recognized all of the current period's fixed overhead as an expense, variable-costing income should be $1,000 lower than absorption-costing income, as it is.

5. Segmented income statement:

	Coin Purses	Key Chains	Total
Sales	$ 495,000	$ 945,000	$1,440,000
Less variable expenses:			
Variable cost of goods sold	(310,500)	(550,200)	(860,700)
Variable selling expenses	(30,000)	(60,000)	(90,000)
Contribution margin	154,500	334,800	489,300
Less direct fixed expenses:			
Fixed overhead	(50,000)	(80,000)	(130,000)
Direct selling expenses	(35,000)	(40,000)	(75,000)
Product margin	$ 69,500	$ 214,800	284,300
Less common fixed expenses:			
Common selling expenses			(50,000)
Operating income			$ 234,300

Key Terms

Absorption costing, 600
Contribution margin variance, 609
Contribution margin volume variance, 610
Dumping, 594
Market share, 613
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Price volume variance, 609
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Sales price variance, 609
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Total (overall) sales variance, 609
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Discussion Questions

1. Define *price elasticity of demand*. Give an example of a product with relatively elastic demand and an example of a product with relatively inelastic demand. (Give examples not given in the text.)
2. What are the features of a perfectly competitive market? Give two examples of competitive markets. How could a firm in such a market move to a less competitive market?
3. How do you calculate the markup on cost of goods sold? Is the markup pure profit? Explain.
4. How does target costing differ from traditional costing? How does a target cost relate to price?
5. What is the difference between penetration pricing and price skimming?
6. Why do gas stations in the middle of town typically charge a little less for gasoline than do gas stations located on highway turnoffs?
7. What is price discrimination? Is it legal?
8. Describe the product life cycle. How do unit-level costs behave in relation to the product life cycle? Batch-level costs? Product-level costs? Facility-level costs?

9. Why do firms measure profit? Why do regulated firms care about the level of profit?
10. What is a segment, and why would a company want to measure profits of segments?
11. Suppose that Alpha Company has four product lines, three of which are profitable and one (let's call it "Loser") that generally incurs a loss. Give several reasons why Alpha Company may choose not to drop the Loser product line.
12. How does absorption costing differ from variable costing? When will absorption-costing operating income exceed variable-costing operating income?
13. What are some advantages and disadvantages of using net income as a measure of profitability?
14. Why do some firms measure customer profitability? In what situation(s) would a firm not want to measure customer profitability?
15. What variances do managers use in trying to understand the difference between actual and planned revenue?

Cornerstone Exercises

Cornerstone Exercise 12-1 MARKUP ON COST, JOB PRICING

OBJECTIVE 2
CORNERSTONE 12-1
SERVICE

Cliff Meyers owns and operates Cliff's Car Repair Company. Cliff maintains and repairs automobiles and trucks. Direct materials and direct labour costs are easy to trace to the jobs. Cliff's income statement for last year is as follows:

Revenues		$273,920
Cost of goods sold:		
Direct materials	$124,000	
Direct labour	45,000	
Overhead	45,000	214,000
Gross profit		59,920
Selling and administrative expenses		19,400
Operating income		$ 40,520

Cliff wants to find a markup on cost of goods sold that will allow him to earn about the same amount of profit on each job as was earned last year.

Required:

1. What is the markup on cost of goods sold (COGS) that will maintain the same profit as last year?
2. A customer brings in a car that needs a water pump replacement and some general maintenance. The job will have the following costs:

Direct materials	$230
Direct labour	50
Applied overhead	20
Total cost	$300

   What is the price that Cliff will quote given the markup percentage calculated in Requirement 1?
3. ***What if*** Cliff wants to calculate a markup on direct materials cost, since it is the largest cost of doing business? What is the markup on direct materials cost that will maintain the same profit as last year? What is the bid price Cliff will use for the job given in Requirement 2 if the markup percentage is calculated on the basis of direct materials cost?

Cornerstone Exercise 12-2 COSTS OF DIFFERENT CUSTOMER CLASSES

OBJECTIVE 3
CORNERSTONE 12-2

Giroux Food Products Company manufactures canned mixed nuts with an average manufacturing cost of $48 per case (a case contains 24 cans of nuts). Garrity sold 150,000 cases last year to the following three classes of customer:

Customer	Price per Case	Cases Sold
Supermarkets	$55	80,000
Small grocers	90	40,000
Convenience stores	88	30,000

The supermarkets require special labelling on each can costing $0.03 per can. They order through electronic data interchange (EDI), which costs Giroux about $50,000 annually in operating expenses and depreciation. Giroux delivers the nuts to the stores and stocks them on the shelves. This distribution costs $50,000 per year.

The small grocers order in smaller lots that require special picking and packing in the factory; the special handling adds $20 to the cost of each case sold. Sales commissions to the independent jobbers who sell Giroux products to the grocers average 10 percent of sales. Bad debts expense amounts to 8 percent of sales.

Convenience stores also require special handling that costs $30 per case. In addition, Giroux is required to co-pay advertising costs with the convenience stores at a cost of $15,000 per year. Frequent stops are made to each convenience store by Giroux delivery trucks at a cost of $30,000 per year.

Required:

1. Calculate the total cost per case for each of the three customer classes.
2. Using the costs from Requirement 1, calculate the profit per case per customer class. Does the cost analysis support the charging of different prices? Why or why not?
3. ***What if*** Giroux charged the average price per case to all customer classes? How would that affect the profit percentages?

OBJECTIVE 5
CORNERSTONE 12-3

Cornerstone Exercise 12-3 ABSORPTION COSTING, VALUE OF ENDING INVENTORY, OPERATING INCOME

Habib Products Inc. began operations in October and manufactured 30,000 units during the month with the following unit costs:

Direct materials	$ 6.00
Direct labour	3.00
Variable overhead	2.00
Fixed overhead*	10.00
Variable marketing cost	2.50

*Fixed overhead per unit = $300,000/30,000 units produced = $10

Total fixed factory overhead is $300,000 per month. During October, 28,000 units were sold at a price of $35, and fixed marketing and administrative expenses were $130,500.

Required:

1. Calculate the cost of each unit using absorption costing.
2. How many units remain in ending inventory? What is the cost of ending inventory using absorption costing?
3. Prepare an absorption-costing income statement for Habib Products Inc. for the month of October.
4. ***What if*** November production was 30,000 units, costs were stable, and sales were 31,000 units? What is the cost of ending inventory? What is operating income for November?

OBJECTIVE 5
CORNERSTONE 12-4

Cornerstone Exercise 12-4 VARIABLE COSTING, VALUE OF ENDING INVENTORY, OPERATING INCOME

Refer to **Cornerstone Exercise 12-3**.

Required:

1. Calculate the cost of each unit using variable costing.
2. How many units remain in ending inventory? What is the cost of ending inventory using variable costing?

3. Prepare a variable-costing income statement for Habib Products Inc. for the month of October.
4. ***What if*** November production was 30,000 units, costs were stable, and sales were 31,000 units? What is the cost of ending inventory? What is operating income for November?

Cornerstone Exercise 12-5 SALES PRICE VARIANCE, PRICE VOLUME VARIANCE, OVERALL SALES VARIANCE

OBJECTIVE 6
CORNERSTONE 12-5
SERVICE

Plenty Company is a pet food wholesale firm. In December, Plenty Company expects to sell 20,000 bags of pet food at an average price of $2.20 per bag. Actual results are 18,500 bags sold at an average price of $2.25 per bag.

Required:

1. Calculate the sales price variance for December.
2. Calculate the price volume variance for December.
3. Calculate the overall sales variance for December. Explain why it is favourable or unfavourable.
4. ***What if*** December sales were actually 22,000 bags? How would that affect the sales price variance? The price volume variance? The overall sales variance?

Cornerstone Exercise 12-6 CONTRIBUTION MARGIN VARIANCE

OBJECTIVE 6
CORNERSTONE 12-6

Park Inc. produces and sells two types of power lawn mowers—the basic mower and the self-propelled mower. Budgeted and actual data for the two models are shown below.

Budgeted Amounts:

	Basic Mower	Self-Propelled Mower	Total
Sales:			
($250 × 15,000)	$3,750,000		
($300 × 45,000)		$13,500,000	$17,250,000
Variable expenses	1,500,000	9,000,000	10,500,000
Contribution margin	$2,250,000	$ 4,500,000	$ 6,750,000

Actual Amounts:

	Basic Mower	Self-Propelled Mower	Total
Sales:			
($238 × 14,800)	$3,522,400		
($310 × 44,000)		$13,640,000	$17,162,400
Variable expenses	1,628,000	7,920,000	9,548,000
Contribution margin	$1,894,400	$ 5,720,000	$ 7,614,400

Required:

1. Calculate the contribution margin variance.
2. ***What if*** actual units sold of the self-propelled mower increased? How would that affect the contribution margin variance? What if actual units sold of the self-propelled mower decreased? How would that affect the contribution margin variance?

OBJECTIVE 6

CORNERSTONE 12-7

Cornerstone Exercise 12-7 CONTRIBUTION MARGIN VOLUME VARIANCE

Refer to **Cornerstone Exercise 12-6**.

Required:

1. Calculate the budgeted average unit contribution margin.
2. Calculate the contribution margin volume variance.
3. ***What if*** actual units sold of the self-propelled mower decreased? How would that affect the contribution margin volume variance? What if actual units sold of the self-propelled mower increased? How would that affect the contribution margin volume variance?

OBJECTIVE 6

CORNERSTONE 12-8

Cornerstone Exercise 12-8 SALES MIX VARIANCE

Refer to **Cornerstone Exercise 12-6**.

Required:

1. Calculate the sales mix variance.
2. ***What if*** actual units sold of the basic mower increased? How would that affect the sales mix variance? What if actual units sold of the self-propelled mower increased? How would that affect the sales mix variance?

OBJECTIVE 6

CORNERSTONE 12-9

Cornerstone Exercise 12-9 MARKET SHARE VARIANCE, MARKET SIZE VARIANCE

Budgeted unit sales for the entire lawn mower industry were 1,200,000 (of all model types), and actual unit sales for the industry were 1,190,000. Recall from **Cornerstone Exercise 12-6** that Park Inc. provided the following information:

	Budgeted	Actual
Sales in units, basic mower	15,000	14,800
Sales in units, self-propelled mower	45,000	44,000
Total contribution margin	$6,750,000	
Budgeted average unit contribution margin	$112.50	

Required:

1. Calculate the market share variance (take percentages out to five significant digits).
2. Calculate the market size variance.
3. ***What if*** Park actually sold a total of 61,000 units (in total of the two models)? How would that affect the market share variance? The market size variance?

Exercises

OBJECTIVE 1

SERVICE

Exercise 12-10 ELASTICITY OF DEMAND AND MARKET STRUCTURE

Janet and Phil Hopkins graduated several years ago with M.S. degrees in accounting and set up a full-service accounting firm. Janet and Phil have many small business clients and have noticed some pricing trends while compiling annual financial statements. The following data are for five of the pizza parlours that are Janet and Phil's clients.

	Quantity Sold	Average Price
Mom's	18,000	$10.00
Dad's	21,000	7.90
Auntie's	22,000	8.00
Uncle's	30,000	7.00
Wally's	24,000	7.50

Required:

1. Is the demand for pizza relatively more elastic or inelastic?
2. What type of market structure characterizes the pizza industry? How do you suppose that Mom's can charge so much more per pizza than Uncle's does?

Exercise 12-11 DEMAND CURVE AND CHARACTERISTICS OF MARKET STRUCTURE

OBJECTIVE 1

SERVICE

Amy Chang wants to start a business supplying florists with field-grown flowers. She has located an appropriate plot of land and believes she can grow daisies, asters, chrysanthemums, carnations, and other assorted types during a nine-month growing period. By growing the flowers in a field as opposed to a greenhouse, Amy expects to save a considerable amount on herbicide and pesticide. She is considering passing the savings along to her customers by charging $1.25 per standard bunch versus the prevailing price of $1.50 per standard bunch.

Amy has turned to her neighbour, Bob Winters, for help. Bob is an accountant in town who is familiar with general business conditions. Bob gathered the following information for Amy:

a. There are 50 growers within a one-hour drive of Amy's land.
b. In general, there is little variability in price. Flowers are treated as commodities, and one aster is considered to be pretty much like any other aster.
c. There are numerous florists in the city, and the amount that Amy would supply could be easily absorbed by the florists at the prevailing price.

Required:

1. What type of market structure characterizes the flower-growing industry in Amy's region? Explain.
2. Given your answer to Requirement 1, what price should Amy charge per standard bunch? Why?

Exercise 12-12 BASICS OF DEMAND, LIFE-CYCLE PRICING

OBJECTIVE 1 4

SERVICE

Paul Bourdain is an accountant just ready to open an accounting firm in his hometown. He has heard that established accountants in town charge $65 per hour. That sounds good to Paul. In fact, he believes that he should be able to charge $75 an hour given his high GPA and the fact that he is up to date on current accounting issues.

Required:

Should Paul charge $75 per hour? What would you advise him to do?

Exercise 12-13 MARKUP ON COST, COST-BASED PRICING

OBJECTIVE 2

SERVICE

Kapoor Designs Company is a general contractor that specializes in custom residential housing. Each job requires a bid that includes Kapoor's direct costs and subcontractor costs as well as an amount referred to as "overhead and profit." Kapoor's bidding policy is to estimate the costs of direct materials, direct labour, and subcontractors' costs. These are totalled, and a markup is applied to cover overhead and profit. In the coming year, the company believes it will be the successful bidder on 20 jobs with the following total revenues and costs:

Revenue		$16,240,000
Direct materials	$3,450,000	
Direct labour	4,100,000	
Subcontractors	6,450,000	14,000,000
Overhead and profit		$ 2,240,000

Required:

1. Given the preceding information, what is the markup percentage on total direct costs?
2. Suppose Kapoor Designs is asked to bid on a job with estimated direct costs of $465,000. What is the bid? If the customer complains that the profit seems pretty high, how might Kapoor counter that accusation?

OBJECTIVE 2

Exercise 12-14 MARKUP ON COST

SERVICE

Many different businesses employ markup on cost to arrive at a price. For each of the following situations, explain what the markup covers and why it is the amount that it is.

a. Department stores have a markup of 100 percent of purchase cost.
b. Jewellery stores charge anywhere from 100 percent to 300 percent of the cost of the jewellery. (The 300 percent markup is referred to as "keystone.")
c. Johnson Construction Company charges 12 percent on direct materials, direct labour, and subcontracting costs.
d. Hamilton Auto Repair charges customers for direct materials and direct labour. Customers are charged $45 per direct labour hour worked on their job; however, the employees actually cost Hamilton $15 per hour.

OBJECTIVE 5

Exercise 12-15 ABSORPTION AND VARIABLE COSTING WITH OVER- AND UNDERAPPLIED OVERHEAD

Egnatia Inc. has just completed its first year of operations. The unit costs on a normal costing basis are as follows:

Manufacturing costs (per unit):	
Direct materials (3 kg @ $1.50)	$ 4.50
Direct labour (0.5 hr @ $14)	7.00
Variable overhead (0.5 hr @ $6)	3.00
Fixed overhead (0.5 hr @ $9)	4.50
Total	$19.00
Selling and administrative costs:	
Variable	$2 per unit
Fixed	$138,000

During the year, the company had the following activity:

Units produced	24,000
Units sold	21,300
Unit selling price	$34
Direct labour hours worked	12,000

Actual fixed overhead was $12,000 less than budgeted fixed overhead. Budgeted variable overhead was $5,000 less than the actual variable overhead. The company used an expected actual activity level of 12,000 direct labour hours to compute the predetermined overhead rates. Any overhead variances are closed to Cost of Goods Sold.

Required:

1. Compute the unit cost using (a) absorption costing and (b) variable costing.
2. Prepare an absorption-costing income statement.
3. Prepare a variable-costing income statement.
4. Reconcile the difference between the two income statements.

OBJECTIVE 5

Exercise 12-16 VARIABLE COSTING, ABSORPTION COSTING

During its first year of operations, Arkady Inc. produced 40,000 plastic snow scoops. Snow scoops are oversized shovel-type scoops that are used to push snow away. Unit sales were 38,200 scoops. Fixed overhead was applied at $0.75 per unit produced. Fixed overhead was underapplied by $2,900. This fixed overhead variance was closed to Cost of Goods Sold. There was no variable overhead variance. The results of the year's operations are as follows (on an absorption-costing basis):

Sales (38,200 units @ $20)	$764,000
Less: Cost of goods sold	546,260
Gross margin	217,740
Less: Selling and administrative expenses (all fixed)	184,500
Operating income	$ 33,240

Required:

1. Calculate the cost of the firm's ending inventory under absorption costing. What is the cost of the ending inventory under variable costing?
2. Prepare a variable-costing income statement. Reconcile the difference between the two income figures.

Exercise 12-17 COST-BASED PRICING, TARGET PRICING

OBJECTIVE 2

SERVICE

Carina Franks operates a catering company in Toronto. She provides food and servers for parties. She also rents tables, chairs, dinnerware, glassware, and linens. Estefan and Maria Montero have contacted Carina about plans for their daughter's graduation party. The Monteros would like a catered affair on the lawn of a rural church. They have requested an open bar, sit-down dinner for 350 people, a large tent, and a dance floor. Of course, they expect Carina to supply serving staff, tables with linens, dinnerware, and glassware. They will handle the flowers, decorations, and hiring the band on their own. Carina put together this bid:

Food (350 × $25)	$ 8,750
Beverages (350 × $15)	5,250
Servers (6 × 4 hours × $10)	240
Bartenders (2 × 4 hours × $10)	80
Clean-up staff (3 × 3 hours × $10)	90
Rental of:	
Dance floor	300
Linens	80
Tables	200
Dinnerware	120
Glassware	150
Total	$15,260

Required:

1. Explain where costs for Carina's services and profit are calculated in the preceding bid.
2. Suppose that the Monteros blanch when they see the preceding bid. One of them suggests that they had hoped to spend no more than $10,000 or so on the party. How could Carina work with the Monteros to achieve a target cost of that amount?
3. Estefan Montero protests the cost of dance floor rental. He said, "I've seen those for rent at U-Rent-It for $75." How would you respond to this remark if you were Carina? (*Hint:* You want this job and so telling him "Go ahead and do it yourself, Cheapskate!" is not an option.)

Exercise 12-18 LIFE-CYCLE PRICING, SALES PRICE, AND PRICE VOLUME VARIANCES

OBJECTIVE 4 6

SERVICE

Data for Thermo Company are as follows:

Budgeted price	$14.30
Actual price	$15.00
Budgeted quantity	1,450
Actual quantity sold	1,500

Required:

1. Calculate the sales price variance.
2. Calculate the price volume variance.
3. Suppose that the product is in the introductory stage of the product life cycle. What information do these two variances provide to Thermo's managers?

Exercise 12-19 PRICING STRATEGY, SALES VARIANCES

OBJECTIVE 1 4 6

Hanadarko Inc. manufactures and sells three products: K, M, and P. In January, Hanadarko Inc. budgeted sales of the following.

	Budgeted Volume	Budgeted Price
Product K	110,000	$45.00
Product M	165,000	21.50
Product P	20,000	20.00

At the end of the year, actual sales revenues for Product K and Product M were $5,600,000 and $3,270,000, respectively. The actual price charged for Product K was $50 and for Product M was $20. Only $10 was charged for Product P to encourage more consumers to buy it, and actual sales revenue equalled $600,000 for this product.

Required:

1. Calculate the sales price and price volume variances for each of the three products based on the original budget.
2. Suppose that Product P is a new product just introduced during the year. What pricing strategy is Hanadarko Inc. following for this product?

Problems

OBJECTIVE 3

Problem 12-20 PRICE DISCRIMINATION, CUSTOMER COSTS

Jorell Inc. manufactures and distributes a variety of labellers. Annual production of labellers averages 340,000 units. A large chain store purchases about 30 percent of Jorell's production. Several thousand independent retail office supply stores purchase the other 70 percent. Jorell incurs the following costs of production per labeller:

Direct materials	$ 8.90
Direct labour	2.40
Overhead	3.20
Total	$14.50

Jorell has two salespeople assigned to the chain store account at a cost of $55,000 each per year. Delivery is made in 1,500 unit batches at a delivery cost of $750 per batch. Eight salespeople service the remaining accounts. They call on the stores and incur salary and mileage expenses of approximately $41,000 each. Delivery costs vary from store to store, averaging $0.60 per unit.

Jorell charges the chain store $16.50 per labeller and the independent office supply stores $20 per labeller.

Required:

Is Jorell's pricing policy supported by cost differences in serving the two different classes of customer? Support your answer with relevant calculations.

OBJECTIVE 5

Problem 12-21 UNIT COSTS, INVENTORY VALUATION, VARIABLE AND ABSORPTION COSTING

Liebman Company produced 90,000 units during its first year of operations and sold 87,000 at $21.80 per unit. The company chose practical activity—at 90,000 units—to compute its predetermined overhead rate. Manufacturing costs are as follows:

Direct materials	$540,000
Direct labour	99,000
Expected and actual variable overhead	369,000
Expected and actual fixed overhead	468,000

Required:

1. Calculate the unit cost and the cost of finished goods inventory under absorption costing.
2. Calculate the unit cost and the cost of finished goods inventory under variable costing.

3. What is the dollar amount that would be used to report the cost of finished goods inventory to external parties. Why?

Problem 12-22 INCOME STATEMENTS, VARIABLE AND ABSORPTION COSTING

OBJECTIVE 5

The following information pertains to Petruchio Inc. for last year:

Beginning inventory, units	1,400
Units produced	120,000
Units sold	118,000
Variable costs per unit:	
Direct materials	$7.00
Direct labour	$10.50
Variable overhead	$3.60
Variable selling expenses	$2.10
Fixed costs per year:	
Fixed overhead	$234,000
Fixed selling and administrative expenses	$236,000

There are no work-in-process inventories. Normal activity is 120,000 units. Expected and actual overhead costs are the same. Costs have not changed from one year to the next.

Required:

1. How many units are in ending inventory?
2. Without preparing an income statement, indicate what the difference will be between variable-costing income and absorption-costing income.
3. Assume the selling price per unit is $29. Prepare an income statement using (a) variable costing and (b) absorption costing.

Problem 12-23 INCOME STATEMENTS AND FIRM PERFORMANCE: VARIABLE AND ABSORPTION COSTING

OBJECTIVE 5

Veracruz Company had the following operating data for its first two years of operations:

Variable costs per unit:	
Direct materials	$ 8.00
Direct labour	4.00
Variable overhead	1.50
Fixed costs per year:	
Overhead	90,000
Selling and administrative	23,450

Veracruz produced 30,000 units in the first year and sold 25,000. In the second year, it produced 25,000 units and sold 30,000 units. The selling price per unit each year was $21. Veracruz uses an actual costing system for product costing.

Required:

1. Prepare income statements for both years using absorption costing. Has firm performance, as measured by income, improved or declined from Year 1 to Year 2?
2. Prepare income statements for both years using variable costing. Has firm performance, as measured by income, improved or declined from Year 1 to Year 2?
3. Which method do you think most accurately measures firm performance? Why?

Problem 12-24 CONTRIBUTION MARGIN VARIANCE, CONTRIBUTION MARGIN VOLUME VARIANCE, SALES MIX VARIANCE

OBJECTIVE 6

Elburty Company provides management services for apartments and rental units. In general, Elburty packages its services into two groups: basic and complete. The basic package includes advertising vacant units, showing potential renters through them, and collecting monthly rent and remitting it to the owner. The complete package adds maintenance of units and bookkeeping to the basic package. Packages are priced on a per-rental unit basis. Actual results from last year are as follows:

	Basic	Complete
Sales (rental units)	1,700	300
Selling price	$130	$280
Variable expenses	$90	$230

Elburty had budgeted the following amounts:

	Basic	Complete
Sales (units)	1,715	285
Selling price	$120	$290
Variable expenses	$90	$240

Required:

1. Calculate the contribution margin variance.
2. Calculate the contribution margin volume variance.
3. Calculate the sales mix variance.

OBJECTIVE 6

Problem 12-25 CONTRIBUTION MARGIN VARIANCE, CONTRIBUTION MARGIN VOLUME VARIANCE, SALES MIX VARIANCE

Laconia Company produces three models of a product. Actual results from last year are as follows:

	Model 1	Model 2	Model 3
Unit sales	2,725	1,310	965
Selling price	$52	$68	$34
Variable expenses	$18	$34	$14

Laconia had budgeted the following amounts:

	Model 1	Model 2	Model 3
Unit sales	2,700	1,300	1,000
Selling price	$50	$70	$30
Variable expenses	$20	$30	$10

Required:

1. Calculate the contribution margin variance.
2. Calculate the contribution margin volume variance.
3. Calculate the sales mix variance.

OBJECTIVE 5

Problem 12-26 IMPACT OF INVENTORY CHANGES ON ABSORPTION-COSTING INCOME, DIVISIONAL PROFITABILITY

Dana Baird was manager of a new Medical Supplies Division. She had just finished her second year and had been visiting with the company's vice president of operations. In the first year, the operating income for the division had shown a substantial increase over the prior year. Her second year saw an even greater increase. The vice president was extremely pleased and promised Dana a $5,000 bonus if the division showed a similar increase in profits for the upcoming year. Dana was elated. She was completely confident that the goal could be met. Sales contracts were already well ahead of last year's performance, and she knew that there would be no increases in costs.

At the end of the third year, Dana received the following data regarding operations for the first three years:

	Year 1	Year 2	Year 3
Production	10,000	11,000	9,000
Sales (in units)	8,000	10,000	12,000
Unit selling price	$10	$10	$10
Unit costs:			
Fixed overhead*	$2.90	$3.00	$3.00
Variable overhead	$1.00	$1.00	$1.00
Direct materials	$1.90	$2.00	$2.00

	Year 1	Year 2	Year 3
Direct labour	$1.00	$1.00	$1.00
Variable selling	$0.40	$0.50	$0.50
Actual fixed overhead	$29,000	$30,000	$30,000
Other fixed costs	$9,000	$10,000	$10,000

*The predetermined fixed overhead rate is based on expected actual units of production and expected fixed overhead. Expected production each year was 10,000 units. Any under- or overapplied fixed overhead is closed to Cost of Goods Sold.

	Yearly Income Statements		
	Year 1	Year 2	Year 3
Sales revenue	$80,000	$100,000	$120,000
Less: Cost of goods sold*	54,400	67,000	86,600
Gross margin	25,600	33,000	33,400
Less: Selling and administrative expenses	12,200	15,000	16,000
Operating income	$13,400	$ 18,000	$ 17,400

*Assumes a LIFO inventory flow, as allowed in the United States.

Upon examining the operating data, Dana was pleased. Sales had increased by 20 percent over the previous year, and costs had remained stable. However, when she saw the yearly income statements, she was dismayed and perplexed. Instead of seeing a significant increase in income for the third year, she saw a small decrease. Surely, the Accounting Department had made an error.

Required:

1. Explain to Dana why she lost her $5,000 bonus.
2. Prepare variable-costing income statements for each of the three years. Reconcile the differences between the absorption-costing and variable-costing incomes.
3. If you were the vice president of Dana's company, which income statement (variable-costing or absorption-costing) would you prefer to use for evaluating Dana's performance? Why?

Problem 12-27 ETHICAL ISSUES, ABSORPTION COSTING, PERFORMANCE MEASUREMENT

OBJECTIVE 3 5 7

Bill Fremont, division controller and CMA, was upset by a recent memo he received from the divisional manager, Steve Preston. Bill was scheduled to present the division's financial performance at headquarters in one week. In the memo, Steve had given Bill some instructions for this upcoming report. In particular, Bill had been told to emphasize the significant improvement in the division's profits over last year. Bill, however, didn't believe that there was any real underlying improvement in the division's performance and was reluctant to say otherwise. He knew that the increase in profits was because of Steve's conscious decision to produce more inventory.

In an earlier meeting, Steve had convinced his plant managers to produce more than they knew they could sell. He argued that by deferring some of this period's fixed costs, reported profits would jump. He pointed out two significant benefits. First, by increasing profits, the division could exceed the minimum level needed so that all the managers would qualify for the annual bonus. Second, by meeting the budgeted profit level, the division would be better able to compete for much-needed capital. Bill objected but had been overruled. The most persuasive counterargument was that the increase in inventory could be liquidated in the coming year as the economy improved. Bill, however, considered this event unlikely. From past experience, he knew that it would take at least two years of improved market demand before the productive capacity of the division was exceeded.

Required:

1. Discuss the behaviour of Steve Preston, the divisional manager. Was the decision to produce for inventory an ethical one?
2. What should Bill Fremont do? Should he comply with the directive to emphasize the increase in profits? If not, what options does he have?
3. Identify any ethical standards that may apply to this situation.

OBJECTIVE 5

Problem 12-28 SEGMENTED INCOME STATEMENTS, ADDING AND DROPPING PRODUCT LINES

Dan Petrov has just been appointed manager of Kirchner Glass Products Division. He has two years to make the division profitable. If the division is still showing a loss after two years, it will be eliminated, and Dan will be reassigned as an assistant divisional manager in another division. The divisional income statement for the most recent year is as follows:

Sales	$4,590,000
Less: Variable expenses	3,953,450
Contribution margin	636,550
Less: Direct fixed expenses	675,000
Divisional margin	(38,450)
Less: Common fixed expenses (allocated)	200,000
Divisional profit (loss)	$ (238,450)

Upon arriving at the division, Dan requested the following data on the division's three products:

	Product A	Product B	Product C
Sales (units)	12,000	14,500	15,000
Unit selling price	$150.00	$120.00	$70.00
Unit variable cost	$100.00	$83.00	$103.33
Direct fixed costs	$100,000.00	$425,000.00	$150,000.00

He also gathered data on a proposed new product (Product D). If this product is added, it will displace one of the current products; the quantity that can be produced and sold will equal the quantity sold of the product it is displacing, although demand limits the maximum quantity that can be sold to 20,000 units. Because of specialized production equipment, it is not possible for the new product to displace part of the production of a second product. The information on Product D is as follows:

Unit selling price	$ 80
Unit variable cost	30
Direct fixed costs	240,000

Required:

1. Prepare segmented income statements for Products A, B, and C.
2. Determine the products that Dan should produce for the coming year. Prepare segmented income statements that prove your combination is the best for the division. By how much will profits improve given the combination that you selected? (*Hint:* Your combination may include one, two, or three products.)

OBJECTIVE 5

Problem 12-29 OPERATING INCOME FOR SEGMENTS

Symetria Inc. manufactures and sells automotive tools through three divisions: Eastern, Southern, and International. Each division is evaluated as a profit centre. Data for each division for last year are as follows:

	Eastern	Southern	International
Sales	$3,150,000	$987,000	$6,500,000
Cost of goods sold	1,580,000	680,000	4,100,000
Selling and administrative expenses	337,000	280,000	620,000

Symetria Inc. had corporate administrative expenses equal to $585,000; these were not allocated to the divisions.

Required:

1. Prepare a segmented income statement for Symetria Inc. for last year.
2. Comment on the performance of each of the divisions.

Problem 12-30 PRODUCT PROFITABILITY

OBJECTIVE 4 5

SERVICE

Porter Insurance Company has three lines of insurance: automobile, property, and life. The life insurance segment has been losing money for the past five quarters, and Leah Harper, Porter's controller, has done an analysis of that segment. She has discovered that the commission paid to the agent for the first year the policy is in place is 55 percent of the first-year premium. The second-year commission is 20 percent, and all succeeding years a commission equal to 5 percent of premiums is paid. No salaries are paid to agents; however, Porter does advertise on television and in magazines. Last year, the advertising expense was $500,000. The loss rate (payout on claims) averages 50 percent. Administrative expenses equal $450,000 per year. Revenue last year was $10,000,000 (premiums). The percentage of policies of various lengths is as follows:

First year in force	65%
Second year	25
More than two years in force	10

Experience has shown that if a policy remains in effect for more than two years, it is rarely cancelled.

Leah is considering two alternative plans to turn this segment around. Plan 1 requires spending $250,000 on improved customer claim service in hopes that the percentage of policies in effect will take on the following distribution:

First year in force	50%
Second year	15
More than two years in force	35

Total premiums would remain constant at $10,000,000, and there are no other changes in fixed or variable cost behaviour.

Plan 2 involves dropping the independent agent and commission system and having potential policyholders phone in requests for coverage. Leah estimates that revenue would drop to $7,000,000. Commissions would be zero, but administrative expenses would rise by $1,200,000, and advertising (including direct mail solicitation) would increase by $1,000,000.

Required:

1. Prepare a variable-costing income statement for last year for the life insurance segment of Porter Insurance Company.
2. What impact would Plan 1 have on income?
3. What impact would Plan 2 have on income?

Problem 12-31 CUSTOMER PROFITABILITY, LIFE-CYCLE REVENUE

OBJECTIVE 4 5

SERVICE

Refer to the original data in **Problem 12-30**. Fred Morton has just purchased a life insurance policy from Porter with premiums equal to $1,500 per year.

Required:

1. Assume Fred holds the policy for one year and then drops it. What is his contribution to Porter's operating income?
2. Assuming Fred holds the policy for three years, what is his contribution to Porter's operating income in the second and third years? Over a three-year period? What implications does this hold for Porter's efforts to retain policyholders?

Problem 12-32 CUSTOMER PROFITABILITY

OBJECTIVE 5

Olin Company manufactures and distributes carpentry tools. Production of the tools is in the mature portion of the product life cycle. Olin has a sales force of 20. Salespeople are paid a commission of 7 percent of sales, plus expenses of $35 per day for days spent on the road away from home, plus $0.30 per kilometre. They deliver products in addition to making the sales, and each salesperson is required to own a truck suitable for making deliveries.

For the coming quarter, Olin estimates the following:

Sales	$1,300,000
Cost of goods sold	450,000

On average, a salesperson travels 6,000 kilometres per quarter and spends 38 days on the road. The fixed marketing and administrative expenses total $400,000 per quarter.

Required:

1. Prepare an income statement for Olin Company for the next quarter.
2. Suppose that a large hardware chain, MegaHardware Inc. wants Olin Company to produce its new SuperTool line. This would require Olin Company to sell 80 percent of total output to the chain. The tools will be imprinted with the SuperTool brand, requiring Olin to purchase new equipment, use somewhat different materials, and reconfigure the production line. Olin's industrial engineers estimate that cost of goods sold for the SuperTool line would increase by 15 percent. No sales commission would be incurred, and MegaHardware would link Olin to its EDI system. This would require an annual cost of $100,000 on the part of Olin. MegaHardware would pay shipping. As a result, the sales force would shrink by 80 percent. Should Olin accept MegaHardware's offer? Support your answer with appropriate calculations.

OBJECTIVE 5

Problem 12-33 SEGMENTED INCOME STATEMENTS, ANALYSIS OF PROPOSALS TO IMPROVE PROFITS

Shannon Inc. has two divisions. One produces and sells paper party supplies (napkins, paper plates, invitations); the other produces and sells cookware. A segmented income statement for the most recent quarter is as follows:

	Party Supplies Division	Cookware Division	Total
Sales	$500,000	$750,000	$1,250,000
Less: Variable expenses	425,000	460,000	885,000
Contribution margin	75,000	290,000	365,000
Less: Direct fixed expenses	85,000	110,000	195,000
Segment margin	$ (10,000)	$180,000	170,000
Less: Common fixed expenses			130,000
Operating income			$ 40,000

On seeing the quarterly statement, Madge Shatsky, president of Shatsky Inc., was distressed and discussed her disappointment with Abdel Sharif, the company's vice president of finance.

MADGE: The Party Supplies Division is killing us. It's not even covering its own fixed costs. I'm beginning to believe that we should shut down that division. This is the seventh consecutive quarter it has failed to provide a positive segment margin. I was certain that Paula Kelly could turn it around. But this is her third quarter, and she hasn't done much better than the previous divisional manager.

ABDEL: Well, before you get too excited about the situation, perhaps you should evaluate Paula's most recent proposals. She wants to spend $10,000 per quarter for the right to use familiar cartoon figures on a new series of invitations, plates, and napkins and at the same time increase the advertising budget by $25,000 per quarter to let the public know about them. According to her marketing people, sales should increase by 10 percent if the right advertising is done—and done quickly. In addition, Paula wants to lease some new production machinery that will increase the rate of production, lower labour costs, and result in less waste of materials. Paula claims that the variable cost ratio will be reduced by 30 percent. The cost of the lease is $95,000 per quarter.

Upon hearing this news, Madge calmed considerably, and, in fact, was somewhat pleased. After all, she was the one who had selected Paula, and she had a great deal of confidence in Paula's judgment and abilities.

Required:

1. Assuming that Paula's proposals are sound, should Madge be pleased with the prospects for the Party Supplies Division? Prepare a segmented income statement for the next quarter that reflects the implementation of Paula's proposals. Assume that the Cookware Division's sales increase by 5 percent for the next quarter and that the same cost relationships hold.
2. Suppose that everything materializes as Paula projected except for both increases in sales—no change in sales revenues takes place. Are the proposals still sound? What if the variable costs are reduced by 40 percent instead of 30 percent with no change in sales?

CMA Problems

CMA Problem 12-1 COST-BASED PRICING*

OBJECTIVE 2

Otero Fibres Inc. specializes in the manufacture of synthetic fibres, which the company uses in many products such as blankets, coats, and uniforms for police and firefighters. Otero has been in business since 1985 and has been profitable every year since 1993. The company uses a standard cost system and applies overhead on the basis of direct labour hours.

Otero has recently received a request to bid on the manufacture of 800,000 blankets scheduled for delivery to the Canadian military. The bid must be stated at full cost per unit plus a return on full cost of no more than 10 percent after income taxes. Full cost has been defined as including all variable costs of manufacturing the product, a reasonable amount of fixed overhead, and reasonable incremental administrative costs associated with the manufacture and sale of the product. The contractor has indicated that bids in excess of $30 per blanket are not likely to be considered.

In order to prepare the bid for the 800,000 blankets, Andrea Lightner, cost accountant, has gathered the following information about the costs associated with the production of the blankets.

Direct material	$1.70 per kilogram of fibres
Direct labour	$6.50 per hour
Direct machine costs*	$10.00 per blanket
Variable overhead	$3.00 per direct labour hour
Fixed overhead	$8.00 per direct labour hour
Incremental administrative costs	$2,450 per 1,000 blankets
Special fee**	$0.50 per blanket
Material usage	3 kilograms per blanket
Production rate	4 blankets per direct labour hour
Effective tax rate	35%

*Direct machine costs consist of items such as special lubricants, replacement of needles used in stitching, and maintenance costs. These costs are not included in the normal overhead rates.

**Otero recently developed a new blanket fibre at a cost of $750,000. In an effort to recover this cost, Otero has instituted a policy of adding a $0.50 fee to the cost of each blanket using the new fibre. To date, the company has recovered $125,000. Lightner knows that this fee does not fit within the definition of full cost, as it is not a cost of manufacturing the product.

Required:

1. Calculate the minimum price per blanket that Otero Fibres could bid without reducing the company's operating income.
2. Using the full-cost criteria and the maximum allowable return specified, calculate Otero Fibres' bid price per blanket.
3. Without prejudice to your answer to Requirement 2, assume that the price per blanket that Otero Fibres calculated using the cost-plus criteria specified is greater than the maximum bid of $30 per blanket allowed. Discuss the factors that Otero Fibres should consider before deciding whether or not to submit a bid at the maximum acceptable price of $30 per blanket. *(CMA adapted)*

OBJECTIVE 5

CMA Problem 12-2 ABSORPTION- AND VARIABLE-COSTING INCOME STATEMENTS*

Leroux Optics Inc. specializes in manufacturing lenses for large telescopes and cameras used in space exploration. As the specifications for the lenses are determined by the customer and vary considerably, the company uses a job-order costing system.

Manufacturing overhead is applied to jobs on the basis of direct labour hours, utilizing the absorption- or full-costing method. Leroux's predetermined overhead rates for 2012 and 2013 were based on the following estimates.

	2012	2013
Direct labour hours	32,500	44,000
Direct labour cost	$325,000	$462,000
Fixed manufacturing overhead	$130,000	$176,000
Variable manufacturing overhead	$162,500	$198,000

Jim Bao, Leroux's controller, would like to use variable (direct) costing for internal reporting purposes as he believes statements prepared using variable costing are more appropriate for making product decisions. In order to explain the benefits of variable costing to the other members of Leroux's management team, Bao plans to convert the company's income statement from absorption costing to variable costing. He has gathered the following information for this purpose, along with a copy of Leroux's 2012 and 2013 comparative income statement.

Leroux Optics Inc.
Comparative Income Statement
For the Years 2012 and 2013

	2012	2013
Net sales	$1,140,000	$1,520,000
Cost of goods sold:		
Finished goods at January 1	16,000	25,000
Cost of goods manufactured	720,000	976,000
Total available	736,000	1,001,000
Less: Finished goods at December 31	25,000	14,000
Unadjusted cost of goods sold	711,000	987,000
Overhead adjustment	12,000	7,000
Cost of goods sold	723,000	994,000
Gross profit	417,000	526,000
Selling expenses	(150,000)	(190,000)
Administrative expenses	(160,000)	(187,000)
Operating income	$ 107,000	$ 149,000

Leroux's actual manufacturing data for the two years are as follows:

	2012	2013
Direct labour hours	30,000	42,000
Direct labour cost	$300,000	$435,000
Direct materials used	$140,000	$210,000
Manufacturing overhead	$132,000	$175,000

The company's actual inventory balances were as follows:

	December 31, 2011	December 31, 2012	December 31, 2013
Direct materials	$32,000	$36,000	$18,000
Work in process:			
Costs	$44,000	$34,000	$60,000
Direct labour hours	1,800	1,400	2,500

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	December 31, 2011	December 31, 2012	December 31, 2013
Finished goods:			
Costs	$16,000	$25,000	$14,000
Direct labour hours	700	1,080	550

For both years, all administrative expenses were fixed, while a portion of the selling expenses resulting from an 8 percent commission on net sales was variable. Leroux reports any over- or underapplied overhead as an adjustment to the cost of goods sold.

Required:

1. For the year ended December 31, 2013, prepare the revised income statement for Leroux Optics Inc. utilizing the variable-costing method. Be sure to include the contribution margin on the revised income statement.
2. Describe two advantages of using variable costing rather than absorption costing. *(CMA adapted)*

CMA Problem 12-3 CONTRIBUTION MARGIN VARIANCE, CONTRIBUTION MARGIN VOLUME VARIANCE, MARKET SHARE VARIANCE, MARKET SIZE VARIANCE*

OBJECTIVE 6

SERVICE

Saini Inc. produces and sells gel-filled ice packs. Saini's performance report for April follows:

	Actual	Budgeted
Units sold	100,000	90,000
Sales	$410,000	$360,000
Variable costs	375,000	315,000
Contribution margin	$ 35,000	$ 45,000
Market size (in units)	1,250,000	1,200,000

Required:

1. Calculate the contribution margin variance and the contribution margin volume variance.
2. Calculate the market share variance and the market size variance. *(CMA adapted)*

CMA Problem 12-4 SEGMENTED REPORTING AND VARIANCES*

OBJECTIVE 5 6

Pitts-Walsh Company (PWC) is a manufacturing company whose product line consists of lighting fixtures and electronic timing devices. The Lighting Fixtures Division assembles units for the upscale and mid-range markets. The Electronic Timing Devices Division manufactures instrument panels that allow electronic systems to be activated and deactivated at scheduled times for both efficiency and safety purposes. Both divisions operate out of the same manufacturing facilities and share production equipment.

PWC's budget for the year ending December 31, 2013, follows and was prepared on a business segment basis under the following guidelines:

a. Variable expenses are directly assigned to the incurring division.
b. Fixed overhead expenses are directly assigned to the incurring division.
c. The production plan is for 8,000 upscale fixtures, 22,000 mid-range fixtures, and 20,000 electronic timing devices. Production equals sales.

PWC established a bonus plan for division management that required meeting the budget's planned operating income by product line, with a bonus increment if the division exceeds the planned product line operating income by 10 percent or more.

PWC Budget
For the Year Ending December 31, 2013
(In thousands of dollars)

	Lighting Fixtures		Electronic	
	Upscale	Mid-Range	Timing Devices	Total
Sales	$1,440	$ 770	$ 800	$ 3,010
Variable expenses:				
Cost of goods sold	(720)	(439)	(320)	(1,479)

(*continued*)

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	Lighting Fixtures		Electronic	
	Upscale	Mid-Range	Timing Devices	Total
Selling and administrative	(170)	(60)	(60)	(290)
Contribution margin	550	271	420	1,241
Fixed overhead expenses	140	80	80	300
Segment margin	$ 410	$ 191	$ 340	$ 941

Shortly before the year began, the CEO, Jack Parkow, suffered a heart attack and retired. After reviewing the 2013 budget, the new CEO, Joe Kudla, decided to close the lighting fixtures mid-range product line by the end of the first quarter and use the available production capacity to grow the remaining two product lines. The marketing staff advised that electronic timing devices could grow by 40 percent with increased direct sales support. Increases above that level and increasing sales of upscale lighting fixtures would require expanded advertising expenditures to increase consumer awareness of PWC as an electronics and upscale lighting fixtures company. Kudla approved the increased sales support and advertising expenditures to achieve the revised plan. Kudla advised the divisions that for bonus purposes the original product-line operating income objectives must be met, but he did allow the Lighting Fixtures Division to combine the operating income objectives for both product lines for bonus purposes.

Prior to the close of the fiscal year, the division controllers were furnished with preliminary actual data for review and adjustment, as appropriate. These preliminary year-end data reflect the revised units of production amounting to 12,000 upscale fixtures, 4,000 mid-range fixtures, and 30,000 electronic timing devices and are presented as follows:

PWC Preliminary Actuals
For the Year Ending December 31, 2013
(In thousands of dollars)

	Lighting Fixtures		Electronic	
	Upscale	Mid-Range	Timing Devices	Total
Sales	$ 2,160	$140	$1,200	$ 3,500
Variable expenses:				
Cost of goods sold	(1,080)	(80)	(480)	(1,640)
Selling and administrative	(260)	(11)	(96)	(367)
Contribution margin	820	49	624	1,493
Fixed overhead expenses	140	14	80	234
Segment margin	$ 680	$ 35	$ 544	$ 1,259

The controller of the Lighting Fixtures Division, anticipating a similar bonus plan for 2014, is contemplating deferring some revenues to the next year on the pretext that the sales are not yet final and accruing in the current year expenditures that will be applicable to the first quarter of 2014. The corporation would meet its annual plan, and the division would exceed the 10 percent incremental bonus plateau in 2013 despite the deferred revenues and accrued expenses contemplated.

Required:

1. Outline the benefits that an organization realizes from segment reporting. Evaluate segment reporting on a variable-costing basis versus an absorption-costing basis.
2. Calculate the contribution margin, contribution margin volume, and sales mix variances.
3. Explain why the variances occurred. *(CMA adapted)*

The Collabourative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

1. Explain what strategic cost management is and how it can be used to help a firm create a competitive advantage.
2. Discuss value-chain analysis and the strategic role of activity-based customer and supplier costing.
3. Tell what life-cycle cost management is and how it can be used to maximize profits over a product's life cycle.
4. Identify the basic features of JIT purchasing and manufacturing.
5. Describe the effect JIT has on cost traceability and product costing.

CHAPTER 13

Strategic Cost Management

Why is one brand of ice cream viewed as better than another brand? It may reflect a deliberate decision by an ice cream producer to design and make an ice cream product that uses special ingredients and flavours rather than simply the ordinary. It is a means of differentiating the product and making it unlike those of competitors. It also may mean a conscious decision has been made to target certain types of consumers—consumers who are willing to pay for a higher-quality, specialized ice cream. Whether this is a good strategy or not depends on its profitability. Cost management plays a vital role in strategic decision making. Cost information is critical in formulating and choosing strategies as well as in evaluating the continued viability of existing strategic positions.

In Chapter 6, the basic concepts of activity-based costing were introduced. These concepts were illustrated using the traditional product cost definition. Activity-based product costing can significantly improve the accuracy of traditional product costs. Thus, inventory valuation is improved, and managers (and other information users) have better information concerning the costs of products, leading to more informed decision making. Yet the value of the traditional product cost definition is limited

and may not be very useful in certain decision contexts. For example, corporations engage in decision making that affects their long-run competitive position and profitability. Strategic planning and decision making require a much broader set of cost information than that provided by product costs. Cost information about customers, suppliers, and different product designs is also needed to support strategic management objectives.

This broader set of information should satisfy two requirements. First, it should include information about the firm's environment and internal workings. Second, it must be prospective and thus should provide insight about future periods and activities. A value-chain framework with cost data to support a **value-chain analysis** satisfies the first requirement. Cost information to support product life-cycle analysis is needed to satisfy the second requirement. Value-chain analysis can produce organizational changes that fundamentally alter the nature and demand for cost information. Just-in-time (JIT) manufacturing is an example of a strategic approach that alters the nature of the cost accounting information system. In this chapter, we introduce strategic cost management, life-cycle cost management, and JIT manufacturing. The JIT approach is used to illustrate the value-chain concepts. However, given the breadth of its application and its effect on cost accounting, JIT is a topic that by itself merits study. Furthermore, JIT's linkages to strategic cost management justify this topic's inclusion in the same chapter with strategic cost management.

OBJECTIVE 1

Explain what strategic cost management is and how it can be used to help a firm create a competitive advantage.

Strategic Cost Management: Basic Concepts

Decision making that affects the long-term competitive position of a firm must explicitly consider the strategic elements of a decision. The most important strategic elements for a firm are its long-term growth and survival. Thus, **strategic decision making** involves choosing among alternative strategies with the goal of selecting a strategy, or strategies, that provide a company with reasonable assurance of long-term growth and survival. The key to achieving this goal is to gain a *competitive advantage*. **Strategic cost management**[1] is the use of cost data to develop and identify superior strategies that will produce a sustainable competitive advantage.

Strategic Positioning: The Key to Creating and Sustaining a Competitive Advantage

Competitive advantage is creating better customer value for the same or lower cost than offered by competitors or creating equivalent value for lower cost than offered by competitors. **Customer value** is the difference between what a customer receives (customer realization) and what the customer gives up (customer sacrifice). What a customer receives is more than simply the basic level of performance provided by a product.[2] What is received is called the *total product*. The **total product** is the complete range of tangible and intangible benefits that a customer receives from a purchased product. Thus, customer realization includes basic and special product features, service, quality, instructions for use, reputation, brand name, and any other factors deemed important by customers. Customer sacrifice includes the cost of purchasing the product, the time and effort spent acquiring and learning to use the product, and **post-purchase costs**, which are the costs of using, maintaining, and disposing of the product.

Increasing customer value to achieve a competitive advantage is tied closely to judicious strategy selection. Three general strategies have been identified: *cost leadership*, *product differentiation*, and *focusing*.[3]

[1] The idea of strategic cost management was introduced by John K. Shank and Vijay Govindarajan in their book *Strategic Cost Management* (The Free Press, 1993).

[2] Keep in mind that our definition of *product* includes services. Services are intangible products.

[3] See M. E. Porter, *Competitive Advantage: Creating and Sustaining Superior Performance* (New York: Free Press, 1985) for a more complete discussion of the three strategic positions.

Cost Leadership The objective of a **cost leadership strategy** is to provide the same or better value to customers at a *lower cost* than offered by competitors. Essentially, if customer value is defined as the difference between realization and sacrifice, a low-cost strategy increases customer value by minimizing customer sacrifice. In this case, cost leadership is the goal of the organization. For example, a company might redesign a product so that fewer parts are needed, lowering production costs and the costs of maintaining the product after purchase.

Differentiation A **differentiation strategy**, on the other hand, strives to increase customer value by increasing what the customer receives (customer realization). A competitive advantage is created by providing something to customers that is not provided by competitors. Therefore, product characteristics must be created that set the product apart from its competitors. This differentiation can occur by adjusting the product so that it is different from the norm or by promoting some of the product's tangible or intangible attributes. Differences can be functional, aesthetic, or stylistic. For example, a retailer of computers might offer on-site repair service, a feature not offered by other rivals in the local market. Or a producer of crackers may offer animal-shaped crackers, as **Nabisco** did with Teddy Grahams®, to differentiate its product from other brands with more conventional shapes. To be of value, however, customers must see the variations as important. Furthermore, the value added to the customer by differentiation must exceed the firm's costs of providing the differentiation. If customers see the variations as important and if the value added to the customer exceeds the cost of providing the differentiation, then a competitive advantage has been established.

Focusing A **focusing strategy** is selecting or emphasizing a market or customer segment in which to compete. One possibility is to select the markets and customers that appear attractive and then develop the capabilities to serve these targeted segments. Another possibility is to select specific segments where the firm's core competencies in the segments are superior to those of competitors. A focusing strategy recognizes that not all segments (e.g., customers and geographic regions) are the same. Given the capabilities and potential capabilities of the organization, some segments are more attractive than others.

Strategic Positioning In reality, many firms will choose not just one general strategy, but a combination of the three general strategies. **Strategic positioning** is the process of selecting the optimal mix of these three general strategic approaches. The mix is selected with the objective of creating a sustainable competitive advantage. A **strategy**, reflecting combinations of the three general strategies, can be defined as:

> *. . . choosing the market and customer segments the business unit intends to serve, identifying the critical internal business processes that the unit must excel at to deliver the value propositions to customers in the targeted market segments, and selecting the individual and organizational capabilities required for the internal, customer, and financial objectives.*[4]

As used in the definition, "choosing the market and customer segments" is actually focusing; "deliver[ing] the value propositions" is choosing to increase customer realization and/or decrease sacrifice and, therefore, entails cost leadership and/or differentiation strategies, or a combination of the two. Developing the necessary capabilities to serve the segments is related to all three general strategies.

What is the role of cost management in strategic positioning? The *objective* of strategic cost management is to *reduce* costs while simultaneously *strengthening* the chosen strategic position. Remember that a competitive advantage is tied to costs. For example, suppose that an organization is providing the same customer value at a higher cost than its competitors. By increasing customer value for specific customer segments (e.g., differentiation and focusing are used to strengthen the strategic position) and, at the same time, *decreasing* costs, the organization might reach a state

[4] Robert S. Kaplan and David P. Norton, *The Balanced Scorecard* (Boston: Harvard Business School Press, 1996): 37.

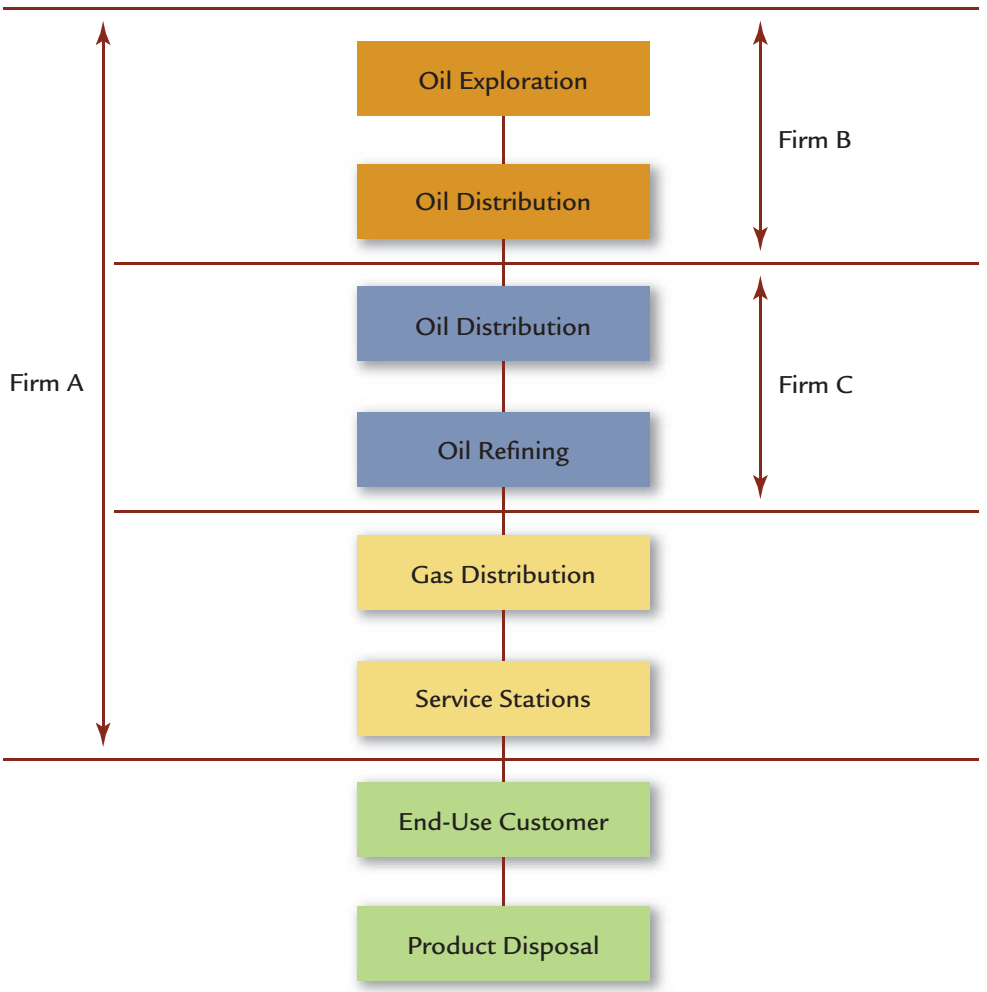
where it is providing greater value at the same or less cost than its competitors, thus creating a competitive advantage.

Industrial Value-Chain Framework, Linkages, and Activities

Choosing an optimal (or most advantageous) strategic position requires managers to understand the activities that contribute to its achievement. Successful pursuit of a sound strategic position mandates an understanding of the *industrial value chain*. The **industrial value chain** is the linked set of value-creating activities from basic raw materials to the disposal of the finished product by end-use customers. Exhibit 13-1 illustrates a possible industrial value chain for the petroleum industry. A given firm operating in the oil industry may not—and likely will not—span the entire value chain. The exhibit illustrates that different firms participate in different portions of the value chain. Most large oil firms such as **ExxonMobil** and **Petro-Canada** (now part of **Suncor**) are involved in the value chain from exploration to service stations (like Firm A in Exhibit 13-1). Yet even these oil giants purchase oil from other producers and also supply gasoline to service station outlets that are owned by others. Furthermore, there are many oil firms that engage exclusively in smaller segments of the chain such as exploration and production or refining and distribution (like Firms B and C in Exhibit 13-1). Regardless of its position in the value chain, to create and

Exhibit 13-1

Value Chain for the Petroleum Industry



sustain a competitive advantage, a firm must understand the entire value chain and not just the portion in which it operates.

Thus, breaking down the value chain into its strategically relevant activities is basic to successful implementation of cost leadership and differentiation strategies. A value-chain framework is a compelling approach to understanding a firm's strategically important activities. Fundamental to a value-chain framework is the recognition that there exist complex linkages and interrelationships among activities both within and beyond the firm. Two types of linkages must be analyzed and understood: *internal linkages* and *external linkages*. **Internal linkages** are relationships among activities that are performed within a firm's portion of the value chain. **External linkages**, on the other hand, describe the relationship of a firm's value-chain activities that are performed with its suppliers and customers. External linkages, therefore, are of two types: *supplier linkages* and *customer linkages*.

External linkages emphasize the fact that a company must understand the entire value chain and not just the portion of the chain in which it participates. An *external* focus is needed for effective strategic cost management. A company cannot ignore supplier and customer linkages and expect to establish a sustainable competitive advantage. A company needs to understand its relative position in the industrial value chain. An assessment of the economic strength and relationships of each stage in the entire value-chain system can provide a company with several significant strategic insights. For example, knowing the revenues and costs of the different stages may reveal the need to forward or backward integrate to increase overall economic performance. Alternatively, it may reveal that divestiture and a narrowing of participation in the industrial value chain is a good strategy. Finally, knowing the supplier power and buyer power can have a significant effect on how external linkages are exploited. Supplier and buyer power can be assessed for a company by comparing the percentage of profits earned in the industrial value chain with the percentages earned by suppliers and by customers. For example, suppose that the profit earned per litre of gasoline by an independent refiner and producer is $0.15 and that the profit earned by a network of service stations that buy the gasoline (not owned by the independent) is $0.05 per litre. The percentage of profit earned in this segment of the value chain by the downstream stage is 25 percent ($0.05/$0.20), while the independent earns 75 percent of the profit. Buyer power is weak relative to the refiner and producer. If, in addition, the return on assets being earned by the service station segment is high, this may reveal that integrating forward is both desirable and possible.

To exploit a firm's internal and external linkages, we must identify the firm's activities and select those that can be used to produce (or sustain) a competitive advantage. This selection process requires knowledge of the cost and value of each activity. For strategic analysis, activities are classified as *organizational activities* and *operational activities*; the costs of these activities, in turn, are determined by *organizational* and *operational cost drivers*.

Organizational Activities and Cost Drivers

Organizational activities are of two types: *structural* and *executional*. **Structural activities** are activities that determine the underlying economic structure of the organization. **Executional activities** are activities that define the processes and capabilities of an organization and thus are directly related to the ability of an organization to execute successfully. **Organizational cost drivers** are structural and executional factors that determine the long-term cost structure of an organization. Thus, there are two types of organizational drivers: *structural cost drivers* and *executional cost drivers*. Possible structural and executional activities with their cost drivers are listed by category in Exhibit 13-2.

As the exhibit shows, it is possible (and perhaps common) that a given organizational activity can be driven by more than one driver. For example, the cost of building plants is affected by number of plants, scale, and degree of centralization. Firms that have a commitment to a high degree of centralization may build larger plants so that there can be more

Exhibit 13-2

Organizational Activities and Drivers

Structural Activities	Structural Cost Drivers
Building plants	Number of plants, scale, degree of centralization
Management structuring	Management style and philosophy
Grouping employees	Number and type of work units
Complexity	Number of product lines, number of unique processes, number of unique parts, degree of complexity
Vertically integrating	Scope, buying power, selling power
Selecting and using process technologies	Types of process technologies, experience
Executional Activities	**Executional Cost Drivers**
Using employees	Degree of involvement
Providing quality	Quality management approach
Providing plant layout	Plant layout efficiency
Designing and producing products	Product configuration
Providing capacity	Capacity utilization

geographic concentration and greater control. Similarly, complexity may be driven by number of different products, number of unique processes, and number of unique parts.

Organizational drivers are factors that affect an organization's long-term cost structure. This is readily understood by simply considering the various drivers shown in Exhibit 13-2. Among the structural drivers are the familiar drivers of scale, scope, experience, technology, and complexity. For example, economies and diseconomies of scale are well-known economic phenomena, and the learning curve effect (experience) is also well documented. An interesting property of structural cost drivers is that more is not always better. Moreover, the efficiency level of a structural driver can change. For example, changes in technology can affect the scale driver by changing the optimal size of a plant. In the steel industry, minimill technology has eliminated scale economies (in the form of megamills) as a competitive advantage. Plants of much smaller scale can now achieve the same level of efficiency once produced only by larger steel plants.

Of more recent interest and emphasis are executional drivers. Considerable managerial effort is being expended to improve how things are done in an organization. Continuous improvement and its many faces (employee empowerment, total quality management, process value analysis, life-cycle assessment, etc.) are what executional efficiency is all about. Consider employee involvement and empowerment. The cost of using employees decreases as the degree of involvement increases. Employee or worker involvement refers to the culture, degree of participation, and commitment to the objective of continuous improvement.

Operational Activities and Drivers

Operational activities are day-to-day activities performed as a result of the structure and processes selected by the organization. Examples include receiving and inspecting incoming parts, moving materials, shipping products, testing new products, servicing products, and setting up equipment. **Operational cost drivers** (activity drivers) are those factors that drive the cost of operational activities. They include such factors as number of parts, number of moves, number of products, number of customer orders, and number of returned products. As should be evident, operational activities and drivers are the focus of activity-based costing. Possible operational activities and their drivers are listed in Exhibit 13-3.

Exhibit 13-3

Operational Activities and Drivers

Unit-Level Activities	Unit-Level Drivers
Grinding parts	Grinding machine hours
Assembling parts	Assembly labour hours
Drilling holes	Drilling machine hours
Using materials	Kilograms of material
Using power	Number of kilowatt-hours
Batch-Level Activities	**Batch-Level Drivers**
Setting up equipment	Number of setups
Moving batches	Number of moves
Inspecting batches	Inspection hours
Reworking products	Number of defective units
Product-Level Activities	**Product-Level Drivers**
Redesigning products	Number of change orders
Expediting	Number of late orders
Scheduling	Number of different products
Testing products	Testing hours

The structural and executional activities define the number and nature of the day-to-day activities performed within the organization. For example, if an organization decides to produce more than one product at a facility, then this structural choice produces a need for scheduling, a product-level activity. Similarly, providing a plant layout defines the nature and extent of the materials handling activity (usually a batch-level activity). Furthermore, although organizational activities define operational activities, analysis of operational activities and drivers can be used to suggest strategic choices of organizational activities and drivers. For example, knowing that the number of moves is a measure of consumption of the materials handling activity by individual products may suggest that resource spending can be reduced if the plant layout is redesigned to reduce the number of moves needed. Operational and organizational activities and their associated drivers are strongly interrelated.

Internal Value Chain

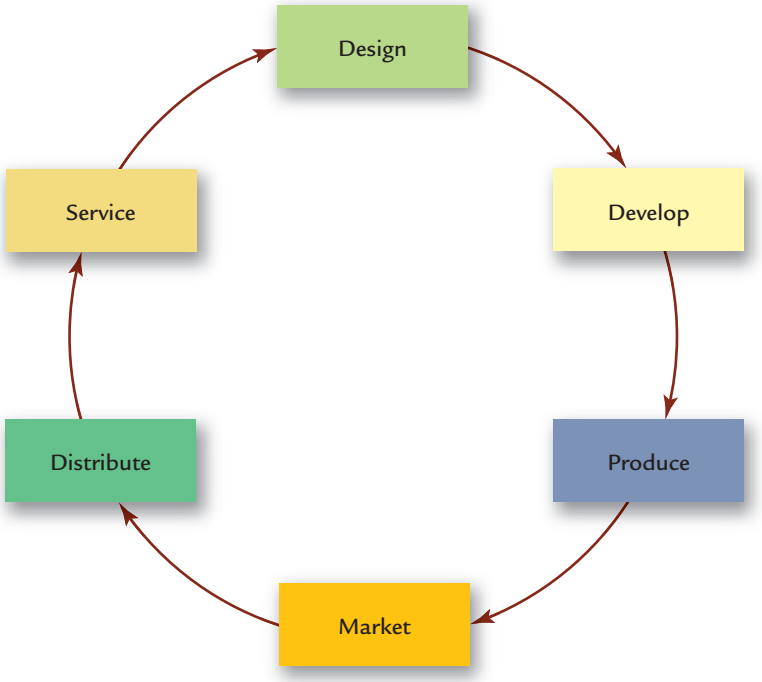
OBJECTIVE 2

Discuss value-chain analysis and the strategic role of activity-based customer and supplier costing.

Sound strategic cost management mandates the consideration of that portion of the value chain in which a firm participates (called the *internal value chain*). Exhibit 13-4 reviews the internal value-chain activities for an organization. Activities before and after production must be identified and their linkages recognized and exploited. Exploiting internal linkages means that relationships between activities are assessed and used to reduce costs and increase value. For example, product design and development activities occur before production and are linked to production activities. The way the product is designed affects the costs of production. How production costs are affected requires a knowledge of cost drivers. Thus, knowing the cost drivers of activities is crucial for understanding and exploiting linkages. If design engineers know that the number of parts is a cost driver for various production activities (material usage, direct labour usage, assembly, inspection, materials handling, and purchasing are examples of activities where costs could be affected by number of parts), then redesigning the product so that it has standard parts, multiple sources, short lead times, and high quality can significantly reduce the overall cost of the product.

Exhibit 13-4

Internal Value Chain



Cornerstone 13-1 illustrates how internal linkages can be exploited to reduce costs in the internal value chain.

Cornerstone 13-1 underscores the importance of individual activities for assessing the impact of the new design. Knowing the cost of different design strategies is made possible by assessing the linkages of activities and the effects of changes in demand for the activities. Notice the key role that the resource usage model plays in this analysis.[5] The purchasing activity currently supplies 15,000 units of activity capacity, acquired in steps of 5,000 units. Capacity is measured in the number of purchase orders. Unused activity for the current product configuration is 2,500 units (15,000 – 12,500). Reconfiguring the product reduces the demand from 12,500 orders to 6,500 orders. This increases the unused activity capacity to 8,500 units (15,000 – 6,500). At this point, management has the capability of reducing resource spending on the resources acquired in advance of usage. Since activity capacity is acquired in chunks of 5,000 units, resource spending can be reduced by $30,000 (the price of one purchasing clerk). Furthermore, since demand decreases, resource spending for the resources acquired as needed is also reduced $3,000 by the variable component ($0.50 × 6,000). The activity-based costing model and knowledge of activity cost behaviour are powerful and integral components of strategic cost management.

In Cornerstone 13-1, the analysis implicitly assumes that resource spending on the engineering design activity would remain unchanged. Therefore, there was no cost to exploiting the linkage. Suppose, however, that an increase in resource spending of $50,000 is needed to exploit the linkages between engineering design and activities downstream in the firm's value chain. Spending $50,000 to save $453,000 is certainly sound. Spending on one activity to save on the cost of other activities is a fundamental principle of strategic cost analysis.

[5] The resource usage model was introduced in Chapter 2.

The HOW and WHY of Exploiting Internal Linkages to Reduce Costs and Increase Value

CORNERSTONE 13-1

Information:

A firm currently produces a high-tech medical product with 20 parts. Design engineering has produced a new configuration for the product that requires only eight parts. Current activity capacity and demand (20-part configuration) and expected activity demand (8-part configuration) are provided.

Activities	Activity Driver	Activity Capacity	Current Activity Demand	Expected Activity Demand
Material usage	Number of parts	200,000	200,000	80,000
Assembling parts	Direct labour hours	10,000	10,000	5,000
Purchasing parts	Number of orders	15,000	12,500	6,500

Additionally, the following activity cost data are provided:

Material usage: $3 per part used; no fixed activity cost.

Assembling parts: $12 per direct labour hour; no fixed activity cost.

Purchasing parts: Three salaried clerks, each earning a $30,000 annual salary; each clerk is capable of processing 5,000 purchase orders. Variable activity costs: $0.50 per purchase order processed for forms, postage, etc.

Why:

Exploiting internal linkages means that relationships between activities in the internal value chain are assessed and used to reduce costs and increase value.

Required:

1. Calculate the cost reduction produced by the new design.
2. Suppose that 10,000 units are being produced and sold for $400 per unit and that the price per unit will be reduced by the per-unit savings. What is the new price for the eight-part configured product?
3. ***What if*** the expected activity demand for purchase orders was 4,500? How would this affect the answers to Requirements 1 and 2?

Solution:

1.

Material usage cost reduction [(200,000 − 80,000)$3]	$360,000
Labour usage cost reduction [(10,000 − 5,000)$12]	60,000
Purchasing cost reduction* [$30,000 + $0.50(12,500 − 6,500)]	33,000
Total savings	$453,000

*Based on the new demand, the number of purchasing agents can be reduced by one, saving $30,000.

2. New price = $400 − ($453,000/10,000) = $354.70

3. Since each purchasing agent can process only 5,000 orders, one agent is needed, saving an additional $30,000 of salary costs. Variable purchasing costs would also drop by an additional $1,000 [$0.50 × (6,500 − 4,500)]. Thus, total savings would increase by $31,000, and the new price would decrease by an additional $3.10 ($31,000/10,000) to $351.60 ($354.70 − $3.10).

Exploiting Supplier Linkages

Although each firm has its own value chain, as was shown in Exhibit 13-1 on page 646, each firm also belongs to a broader value chain—the *industrial value chain*. The value-chain system also includes value-chain activities that are performed by suppliers and buyers. A firm cannot ignore the interaction between its own value-chain activities and those of its suppliers and buyers. Linkages with activities external to the firm can also be exploited. Exploiting external linkages means managing these linkages so that both the company and the external parties receive an increase in benefits.

Suppliers provide inputs and, as a consequence, can have a significant effect on a user's strategic positioning. For example, assume that a company adopts a *total quality management* approach to differentiate and reduce overall quality costs. **Total quality management** is an approach to managing quality that demands the production of defect-free products. Reducing defects, in turn, reduces the total costs spent on quality activities. Yet if the components are delivered late and are of low quality, then there is no way the buying company can produce high-quality products and deliver them on time to its customers. To achieve a defect-free state, a company is strongly dependent on its suppliers' ability to provide defect-free parts. Once this linkage is understood, then a company can work closely with its suppliers so that the product being purchased meets its needs.

Honeywell understands this linkage and has established a supplier review board with the objective of improving business relationships and material quality. Its evaluation and selection of suppliers is based on factors such as product quality, delivery, reliability, continuous improvement, product price, and overall relations. Suppliers are expected to meet certain quality and delivery standards such as 500 parts per million (defect rate), 99 percent on-time delivery, and a 99 percent lot acceptance rate.[6]

Managing Procurement Costs Using Activity-Based Costing To encourage purchasing managers to choose suppliers whose quality, reliability, and delivery performance are acceptable, two essential requirements have been identified.[7] First, a broader view of component costs is needed. Unit-based costing systems typically reward purchasing managers solely on purchase price (e.g., materials price variances). A broader view means that the costs associated with quality, reliability, and late deliveries are added to the purchase costs. Purchasing managers are then required to evaluate suppliers based on total cost, not just purchase price. Second, supplier costs are assigned to products using causal relationships.

Activity-based costing is the key to satisfying both requirements. To satisfy the first requirement, suppliers are defined as a cost object and costs relating to purchase, quality, reliability, and delivery performance are traced to suppliers. In the second case, products are the cost objects, and supplier costs are traced to specific products. By tracing supplier costs to products—rather than averaging them over all products as unit-based costing does—managers can see the effect of large numbers of unique components requiring specialty suppliers versus products with only standard components. Knowing the costs of more complex products helps product designers better evaluate the trade-offs between functionality and cost as they design new products. Additional functions should provide more benefits (by an increased selling price) than costs. By accurately tracing supplier costs to products, a better understanding of product profitability is produced, and product designers are more capable of choosing among competing product designs. Cornerstone 13-2 illustrates the concepts and calculations associated with activity-based supplier costing.

[6] As reported at http://www.honeywell.com on May 15, 2009.

[7] These requirements are discussed in Robin Cooper and Regine Slagmulder, "The Scope of Strategic Cost Management," *Management Accounting* (February 1998): 16–18. Much of the discussion in this section is based on this article.

The HOW and WHY of Activity-Based Supplier Costing

CORNERSTONE 13-2

Information:

A purchasing manager uses two suppliers for the source of two electronic components, X1Z and Y2Z. Data associated with these two components are supplied below.

I. Activity Costs (component failure and late delivery are attributable to suppliers; process failure is caused by internal processes):

Activity	Component Failure/ Late Delivery	Process Failure
Reworking products	$200,000	$40,000
Expediting products	50,000	10,000

II. Supplier Data

	Fielding Electronics		Oro Limited	
	X1Z	Y2Z	X1Z	Y2Z
Unit purchase price	$10	$26	$12	$28
Units purchased	40,000	20,000	5,000	5,000
Failed units	800	190	5	5
Late shipments	30	20	0	0

Why:

Activity-based supplier costing uses drivers to trace costs associated with quality, reliability, and late deliveries to individual suppliers and adds these costs to the direct purchase costs. This enables managers to improve their evaluation and selection of suppliers, with the objective of reducing total supplier costs.

Required:

1. Calculate the activity rates for assigning costs to suppliers.
2. Calculate the total unit purchasing cost for each component for each supplier.
3. ***What if*** the quantity of X1Z that can be purchased is limited to 50,000 units from Fielding and 30,000 units from Oro Limited? There is no limit from either source for Y2Z. Based on cost, what purchasing mix should be chosen?

Solution:

1. Reworking rate = $200,000/1,000* = $200 per failed component

   *(800 + 190 + 5 + 5)

   Expediting rate = $50,000/50* = $1,000 per late delivery

   *(30 + 20)

2.

	Fielding Electronics		Oro Limited	
	X1Z	Y2Z	X1Z	Y2Z
Reworking products:				
$200 × 800	$160,000			
$200 × 190		$38,000		
$200 × 5			$1,000	
$200 × 5				$1,000

CORNERSTONE 13-2 *(continued)*

	Fielding Electronics		Oro Limited	
	X1Z	Y2Z	X1Z	Y2Z
Expediting products:				
$1,000 × 30	30,000			
$1,000 × 20		20,000		
Total costs	$190,000	$ 58,000	$ 1,000	$ 1,000
Units	÷ 40,000	÷ 20,000	÷ 5,000	÷ 5,000
Unit cost	4.75	2.90	0.20	0.20
Unit purchase cost	10.00	26.00	12.00	28.00
Total unit supplier cost	$ 14.75	$ 28.90	$ 12.20	$ 28.20

3. Based on lowest cost: X1Z: 15,000 units from Fielding and 30,000 units from Oro; Y2Z: 0 from Fielding and 25,000 from Oro.

The results of Cornerstone 13-2 show that the "low-cost" supplier actually costs more when the linkages with the internal activities of reworking and expediting are considered. If the purchasing manager is provided with all costs, then the choice becomes clear: Oro Limited is the better supplier. It provides a higher-quality product on a timely basis and at a lower overall cost per unit.

Exploiting Customer Linkages

Customers can also have a significant influence on a firm's strategic position. Choosing marketing segments, of course, is one of the principal elements that define strategic position. For example, selling a medium-level quality product to low-end dealers for a special, low price because of idle capacity could threaten the main channels of distribution for the product. This is true even if the dealers apply their own private labels to the product. Why? Because selling the product to low-end dealers creates a direct competitor for its regular, medium-level dealers. Potential customers of the regular retail outlets could switch to the lower-end outlets because they can buy the same quality for a lower price. And what if the regular outlets deduce what has happened? What effect would this have on the company's medium-level differentiation strategy? The long-term damage to the company's profitability may be much greater than any short-run benefit from selling the special order.

Managing Customer Costs A key objective for strategic costing is the identification of a firm's sources of profitability. In a unit-based costing system, selling and general and administrative costs are usually treated as period costs and, if assigned to customers, are typically assigned in proportion to the revenues generated. Thus, the message of unit-based costing is that servicing customers either costs nothing or they all appear to cost the same percentage of their sales revenue. If customer-servicing costs are significant, then failure to assign them at all or to assign them accurately will prevent sales representatives from managing the customer mix effectively. Why? Because sales representatives will not be able to distinguish between customers who place significant demands on servicing resources and those who place virtually no demand on these resources. This lack of knowledge can lead to actions that will weaken a firm's strategic position. To avoid this outcome and encourage actions that strengthen strategic position, customer-related costs should be assigned to customers using activity-based costing. Accurate assignment of customer-related costs allows the firm to classify customers as profitable or unprofitable. For example, using activity-based customer

costing, a small Polish company found that only 400 out of almost 1,400 customers were profitable.[8] Some of the most regular customers were actually in the unprofitable category. Analysis revealed that the most profitable customers were those who placed large orders, paid on time, received moderate volume discounts, ordered standard products, and required standard delivery conditions. Analysis of customer profitability also revealed that the most significant problem causing unprofitability was small orders.

Once customers are identified as profitable or unprofitable, actions can be taken to strengthen the strategic position of the firm. For profitable customers, an organization can undertake efforts to increase satisfaction by offering higher levels of service, lower prices, new services, or some combination of the three. For unprofitable customers, an organization can attempt to deliver the customer services more efficiently (thus, decreasing service costs), increase prices to reflect the cost of the resources being consumed, encourage unprofitable customers to leave (by reducing selling efforts to this segment), or some combination of the three actions. Cornerstone 13-3 illustrates the power and utility of activity-based customer costing.

Cornerstone 13-3 reveals some interesting insights concerning the benefits of activity-based customer costing. First, some customers may benefit by price corrections. The large customer, for example, could be granted an immediate price decrease. This price decrease would also benefit Thompson, because the price correction is needed to maintain half of its current business. A company, however, such as Thompson may also face the difficult task of announcing a price increase for some of its customers (such is the prospect regarding the 10 smaller customers). However, activity-based customer analysis should go much deeper than accurate cost assignment and fair pricing. For Thompson, identifying the right cost driver (number of orders processed) revealed a linkage between the order-filling activity and customer behaviour. Smaller, frequent orders were imposing costs on Thompson, which were then passed on to all customers through the use of the sales volume allocation. Since the total cost is marked up 20 percent, the price charged was even higher. Furthermore, decreasing the number of orders can decrease order-filling costs. Knowing this, Thompson could offer price discounts for larger orders. For example, providing an incentive (quantity discounts) to increase the size of the orders of the small customers can create sufficient savings to make it unnecessary to increase the selling price to the smaller customers. But there are other possible linkages as well. Larger and less frequent orders will also decrease the demand on other internal activities, such as setting up equipment and materials handling. Reduction in other activity demands could produce further cost reductions and additional price cuts, making companies like Thompson more competitive. Ultimately, exploiting customer linkages can make both the seller and the buyer better off.

Life-Cycle Cost Management

OBJECTIVE 3
Tell what life-cycle cost management is and how it can be used to maximize profits over a product's life cycle.

Strategic cost management emphasizes the importance of an external focus and the need to recognize and exploit both internal and external linkages. Life-cycle cost management is a related approach that builds a conceptual framework which facilitates management's ability to exploit internal and external linkages. To understand what is meant by life-cycle cost management, we first need to understand basic product life-cycle concepts.

Product Life-Cycle Viewpoints

Product life cycle is simply the time a product exists—from conception to abandonment. Usually, product life cycle refers to a product class as a whole—such as automobiles—but it can also refer to specific forms (such as station wagons) and to

[8] Dorota Kuchta and Michal Troska, "Activity-Based Costing and Customer Profitability," *Cost Management* (May/June 2007): 18–25.

CORNERSTONE 13-3

The HOW and WHY of Activity-Based Customer Costing

Information:

Thompson Company produces precision parts for 11 major buyers. Of the 11 customers, one accounts for 50 percent of sales and the other 10 account for the remainder of sales, who purchase parts in roughly equal quantities. Orders are priced by adding manufacturing cost to ordering costs and then adding a 20 percent markup. Under this pricing structure, the large customer approaches Thompson and reveals a bid from a Thompson competitor that is $0.50 per part less than Thompson charges and threatens to take its business elsewhere without a price concession.

	One Large Customer	Ten Smaller Customers
Units purchased	500,000	500,000
Orders placed	2	200
Manufacturing cost	$3,000,000	$3,000,000
Order-filling cost allocated*	$303,000	$303,000
Order cost per unit	$0.606	$0.606

*Order-filling capacity is purchased in blocks (steps) of 45, each step costing $40,400; variable order-filling activity costs are $2,000 per order. The activity capacity is 225 orders; thus, the total order-filling cost is $606,000 [(5 × $40,400) + ($2,000 × 202)]. Current practice allocates ordering cost in proportion to the units purchased; therefore, the large customer receives half the total ordering cost.

Why:

Activity-based customer costing assigns the costs of customer-caused activities to individual customers or customer types. Customers can then be classified as profitable or unprofitable (or as causing or not causing inefficiencies), and actions can be taken to improve efficiency and profitability.

Required:

1. Calculate the unit price offered to Thompson's customers using the current order-filling cost allocation.
2. Assume that a newly implemented ABC system concludes that the number of orders placed is the best cost driver for the order-filling activity. Assign order-filling costs using this driver to each customer type and then calculate the new unit price for each customer type. Can Thompson beat the bid of its competitor?
3. ***What if*** Thompson offers a discount for orders of 10,000 units or more to the smaller customers? Assume that all the small customers can and do take advantage of this offer at the minimum level possible. Can Thompson offer the original price of $7.93 (from Requirement 1) to the small customers and not decrease its profitability?

Solution:

1. Unit price for each customer type = [($3,000,000 + $303,000) × 1.20]/500,000 = $7.93 per unit (rounded to the nearest cent)
2. Order-filling rate = $606,000/202 = $3,000 per order. Large customer ordering cost = $3,000 × 2 = $6,000; Small customer ordering cost = $3,000 × 200 = $600,000. Large customer unit price = [($3,000,000 + $6,000) × 1.20]/500,000 = $7.21 (rounded to the nearest cent); Small customer unit price = [($3,000,000 + $600,000) × 1.20]/500,000 = $8.64. The new large customer price is $0.72 ($7.93 − $7.21) less and easily beats the competitor's price.
3. The number of orders for the 10 smaller customers would decrease to 50 (500,000/10,000). This means that the total order-filling cost would decrease to $184,800 [(2 × $40,400) + ($2,000 × 52)]. Thus, the new order-filling rate would be $184,800/52 = $3,554 (rounded to the nearest dollar); therefore, the new small customer ordering cost = $3,554 × 50 = $177,700. Finally, the new small customer unit price = [($3,000,000 + $177,700) × 1.20]/500,000 = $7.63 (rounded to the nearest dollar). This price would be less than the original price.

specific brands or models (such as a **Toyota** Camry). Also, by replacing "conception" with "purchase," we obtain a customer-oriented definition of product life cycle. The producer-oriented definition refers to the life of classes, forms, or brands, whereas the customer-oriented definition refers to the life of a specific unit of product. These producer and customer orientations can be refined by looking at the concepts of revenue-producing life and consumable life. **Revenue-producing life** is the time a product generates revenue for a company. A product begins its revenue-producing life with the sale of the first product. **Consumable life**, on the other hand, is the length of time that a product serves the needs of a customer. Revenue-producing life is clearly of most interest to the producer, while consumable life is of most interest to the customer. Consumable life, however, is also of interest to the producer because it can be used as a competitive tool.

Marketing Viewpoint The producer of goods or services has two viewpoints concerning product life cycle: the marketing viewpoint and the production viewpoint. The marketing viewpoint describes the general sales pattern of a product as it passes through distinct life-cycle stages. Exhibit 13-5 illustrates the general pattern of the marketing view of product life cycle. The distinct stages identified by the exhibit are introduction, growth, maturity, and decline. The **introduction stage** is characterized by preproduction and startup activities, where the focus is on obtaining a foothold in the market. As the graph indicates, there are no sales for a period of time (the preproduction period) and then slow sales growth as the product is introduced. The **growth stage** is a period of time when sales increase more quickly. The **maturity stage** is a period of time when sales increase more slowly. Eventually, the slope (of the sales curve) in the maturity stage becomes neutral and then turns negative. This **decline stage** is when the product loses market acceptance and sales begin to decrease.

Production Viewpoint The production viewpoint of the product life cycle defines stages of the life cycle by changes in the type of activities performed: research and development activities, production activities, and logistical activities. The production viewpoint emphasizes life-cycle costs, whereas the market viewpoint emphasizes sales revenue behaviour. **Life-cycle costs** are all costs associated with the product for its

Exhibit 13-5

General Pattern of Product Life Cycle: Marketing Viewpoint

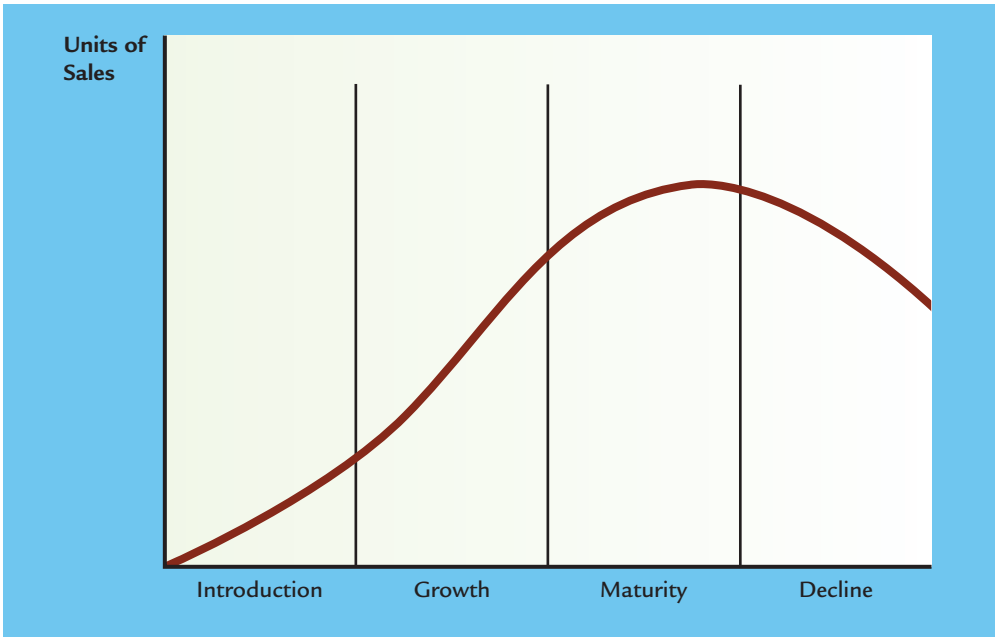
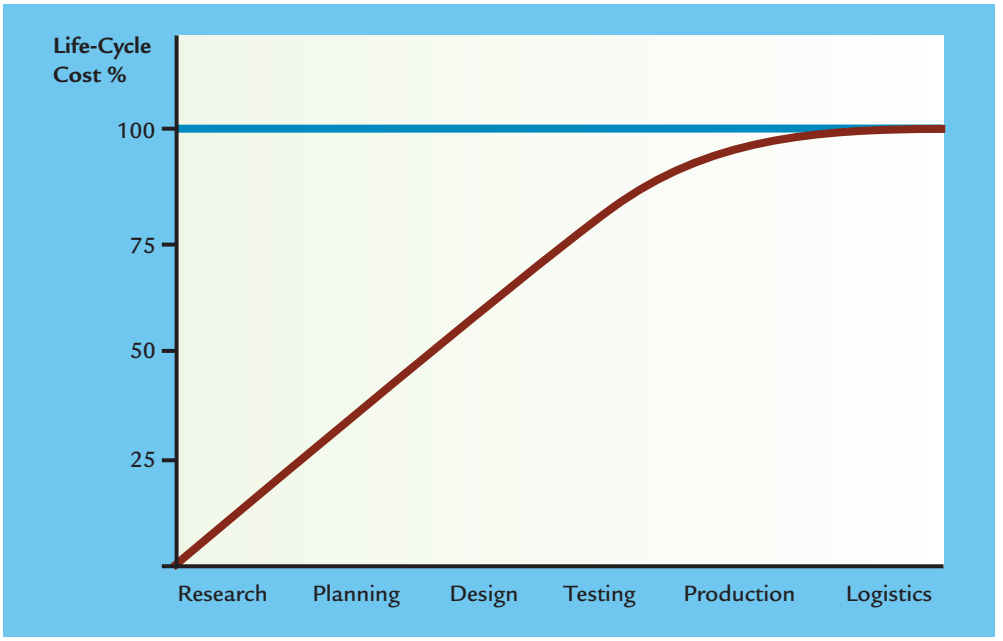


Exhibit 13-6

Product Life Cycle: Production Viewpoint



entire life cycle. These costs include research (product conception), development (planning, design, and testing), production (conversion activities), and logistics support (advertising, distribution, warranty, customer service, product servicing, and so on). The product life cycle and the associated cost commitment curve are illustrated in Exhibit 13-6. Notice that 90 percent or more of the costs associated with a product are *committed* during the development stage of the product's life cycle. Committed means that most of the costs that will be incurred are predetermined—set by the nature of the product design and the processes needed to produce the design.

Consumable Life-Cycle Viewpoint Like the production life cycle, the consumption life cycle's stages are related to activities. These activities define four stages: purchasing, operating, maintaining, and disposal. The consumable life-cycle viewpoint emphasizes product performance for a given price. Price refers to the costs of ownership, which include the following elements: purchase cost, operating costs, maintenance costs, and disposal costs. Thus, total customer satisfaction is affected by both the purchase price and post-purchase costs. Because customer satisfaction is affected by post-purchase costs, producers also have a vital interest in managing the level of these costs. How producers can exploit the linkage of post-purchase activities with producer activities is a key element of product life-cycle cost management.

Interactive Viewpoint

All three life-cycle viewpoints offer insights that can be useful to producers of goods and services. In fact, producers cannot afford to ignore any of the three. A comprehensive life-cycle cost management program must pay attention to the variety of viewpoints that exist. This observation produces an integrated, comprehensive definition of life-cycle cost management. **Life-cycle cost management** consists of actions taken that cause a product to be designed, developed, produced, marketed, distributed, operated, maintained, serviced, and disposed of so that life-cycle profits are maximized. Maximizing life-cycle profits means that producers must understand and capitalize on the relationships that exist among the three life-cycle viewpoints. Once these relationships are understood, actions can be implemented that take advantage of revenue enhancement and cost reduction opportunities.

Relationships among Life-Cycle Viewpoints The marketing viewpoint is concerned with the nature of the sales pattern over the life cycle of the product; it is a *revenue-oriented viewpoint*. The production viewpoint, however, emphasizes the internal activities needed to develop, produce, market, and service products. The production stages exist to support the sales objectives of the marketing stages. This sales support requires resource expenditure; thus, the production life cycle can be described as a *cost-oriented viewpoint*. The consumption life cycle is concerned with product performance and price (including post-purchase costs). The ability to generate revenues and the level of resource expenditure are both related to product performance and price. The producer must be concerned with what the customer receives and what the customer gives up. Thus, the consumption life cycle can be described as a *customer-value oriented viewpoint*. Exhibit 13-7 illustrates the relationships among the stages of the three viewpoints. The stages of the marketing viewpoint are listed as columns; production and consumable life-cycle viewpoints appear as rows. These last two viewpoints are identified by the nature of their attributes: expenses for the production life cycle and customer value for the consumable life cycle. Competition and customer type are included under customer value because they affect the producer's approach to providing customer value.

The relationships described in Exhibit 13-7 are typical but can vary depending on the nature of the product and the industry in which a producer operates. Some explanation of the relationships should reveal the potential for producers to exploit them. Relationships can be viewed vertically or horizontally. Consider, for example, the introduction stage, and examine the vertical relationships. In this stage, we would expect losses or negligible profits because of high levels of expenditure in research and

Exhibit 13-7

Typical Relationships of Product Life-Cycle Viewpoints

Marketing Product Life Cycle:				
Attributes	**Introduction**	**Growth**	**Maturity**	**Decline**
Sales	Low	Rapid growth	Slow growth, peak sales	Declining
Production Life Cycle:				
Attributes	**Introduction**	**Growth**	**Maturity**	**Decline**
Expenses:				
Product research	High	Moderate	Moderate	Low
Product development	Moderate	High	Moderate	Low
Plant and equipment	Low to moderate	High	Moderate	Low
Advertising	Moderate to high	High	Moderate	Low
Service	Low	Moderate	High	Low
Consumable Life Cycle:				
Attributes	**Introduction**	**Growth**	**Maturity**	**Decline**
Customer value:				
Customer type	Innovators	Mass market	Mass market, differentiated	Laggards
Performance sensitivity	High	High	High	Moderate
Price sensitivity	Low	Moderate	High	Moderate
Competition	None	Growing	High	Low
Attributes	**Introduction**	**Growth**	**Maturity**	**Decline**
Profits	Negligible to loss	Peak levels	Moderate to high	Low

development and marketing. Customers at this stage are described as innovators. These are simply the first customers to buy the product. Innovators are venturesome, willing to try something new. They are usually more concerned with the performance of the new product than with its price. This fact, coupled with the lack of competitors, may allow a high price to be charged for the new product. If the barriers to entry in the marketplace are high, then a high price may continue to be charged for some time. However, if competition grows as indicated by the horizontal dimension of the table, and if price sensitivity increases, then the producer will need to rely on further research and development and differentiation to maintain a competitive advantage.

Revenue Enhancement Revenue-generating approaches depend on marketing life-cycle stages and on customer value effect. Pricing strategy, for example, varies with stages. In the introductory stage, as mentioned earlier, higher prices can be charged because customers are less price sensitive and more interested in performance.

In the maturity stage, customers are highly sensitive to both price and performance. This suggests that adding features, increasing durability, improving maintainability, and offering customized products may all be good strategies to follow. In this stage, differentiation is important. For revenue enhancement to be viable, however, the customer must be willing to pay a premium for any improvement in product performance. Furthermore, this premium must exceed the cost the producer incurs in providing the new product attribute. In the decline stage, revenues may be enhanced by finding new uses and new customers for the product. A good example is the use of **Arm & Hammer**'s® baking soda to absorb refrigerator odors in addition to its normal role in baking goods.[9]

Cost Reduction Cost reduction, not cost control, is the emphasis of life-cycle cost management. Cost reduction strategies should explicitly recognize that actions taken in the early stages of the production life cycle can lower costs for later production and consumption stages. Since 90 percent or more of a product's life-cycle costs are determined during the development stage, it makes sense to emphasize management of activities during this phase of a product's existence. Studies have shown that every dollar spent on preproduction activities saves $8–$10 on production and postproduction activities, including customer maintenance, repair, and disposal costs.[10] Apparently, many opportunities for cost reduction occur before production begins. Managers need to invest more in preproduction assets and dedicate more resources to activities in the early phases of the product life cycle to reduce production, marketing, and post-purchase costs.

Product design and process design afford multiple opportunities for cost reduction by designing to reduce: (1) manufacturing costs, (2) logistical support costs, and (3) post-purchase costs, which include customer time involved in maintenance, repair, and disposal. For these approaches to be successful, managers of producing companies must have a good understanding of activities and cost drivers and know how the activities interact. Manufacturing, logistical, and post-purchase activities are not independent. Some designs may reduce post-purchase costs and increase manufacturing costs. Others may simultaneously reduce production, logistical, and post-purchase costs.

A unit-based costing system usually will not supply the information needed to support life-cycle cost management. Unit-based costing systems emphasize the use of unit-based cost drivers to describe cost behaviour, focus on production activities, ignore logistical and post-purchase activities, and expense research and development and other nonmanufacturing costs as they are incurred. Unit-based costing systems rarely, if ever, collect a complete history of a product's costs over its life cycle. An activity-based costing system, however, produces information about activities, including both preproduction and postproduction activities, and cost drivers. Activity-based costing information is critical for life-cycle cost reduction decisions as is shown by Cornerstone 13-4.

[9] Sak Onkvisit and John J. Shaw, "Competition and Product Management: Can the Product Life Cycle Help?" *Business Horizons* (July–August 1986): 51–52.

[10] Mark D. Shields and S. Mark Young, "Managing Product Life Cycle Costs: An Organizational Model" and R. L. Engwall, "Cost Management for Defense Contractors," *Cost Accounting for the 90's, Responding to Technological Change* (Montvale, NJ: National Association of Accountants, 1988).

The HOW and WHY of Activity-Based Life-Cycle Cost Reduction

CORNERSTONE 13-4

Information:

Design engineers are considering two new product designs that reduce direct materials and direct labour content. Data for both unit-based and ABC systems are provided below.

Unit-based system:

Variable conversion activity rate: $40 per direct labour hour

Material usage rate: $8 per part

ABC system:

Labour usage: $10 per direct labour hour

Material usage (direct materials): $8 per part

Machining: $28 per machine hour

Purchasing activity: $60 per purchase order

Setup activity: $1,000 per setup hour

Warranty activity: $200 per returned unit (usually requires extensive rework)

Customer repair cost: $10 per repair hour

Activity and Resource Information (annual estimates)

	Design A	Design B
Units produced	10,000	10,000
Direct material usage	100,000 parts	60,000 parts
Labour usage	50,000 hours	80,000 hours
Machine hours	25,000	20,000
Purchase orders	300	200
Setup hours	200	100
Returned units	400	75
Repair time (customer)	800 hours	150 hours

Why:

ABC produces better and more detailed information for cost reduction decisions concerning process and product designs by recognizing that manufacturing, logistical, and post-purchase activities are not independent.

Required:

1. Select the lower-cost design using unit-based costing. Are logistical and post-purchase activities considered in this analysis?
2. Select the lower-cost design using ABC analysis. Explain why the analysis differs from the unit-based analysis.
3. ***What if*** the customer repair cost were $10 *per unit* for Design A and $50 per unit for Design B? Assume that every unit must face repair by the consumer during the consumable life cycle. Now which is the better design?

CORNERSTONE 13-4 *(continued)*

Solution:

1.

	Design A	Design B
Direct materials[a]	$ 800,000	$ 480,000
Conversion cost[b]	2,000,000	3,200,000
Total manufacturing costs	$2,800,000	$3,680,000
Units produced	÷ 10,000	÷ 10,000
Unit cost	$ 280	$ 368

[a]$8 × 100,000; $8 × 60,000
[b]$40 × 50,000; $40 × 80,000

Logistical and post-purchase costs are not considered.

2.

	Design A	Design B
Direct materials	$ 800,000	$ 480,000
Direct labour[a]	500,000	800,000
Machining[a]	700,000	560,000
Purchasing[b]	18,000	12,000
Setups[b]	200,000	100,000
Warranty[b]	80,000	15,000
Total product costs	$2,298,000	$1,967,000
Units produced	÷ 10,000	÷ 10,000
Unit cost	$ 230*	$ 197*
Post-purchase costs[c]	$ 8,000	$ 1,500

[a] $10 × 50,000; $10 × 80,000; $28 × 25,000; $28 × 20,000
[b] $60 × 300; $60 × 200; $1,000 × 200; $1,000 × 100; $200 × 400; $200 × 75
[c] $10 × 800; $10 × 150
*Rounded to the nearest dollar.

ABC assigns manufacturing costs using both unit and non-unit drivers. It also considers the effects of manufacturing, logistical, and post-purchase activities (unit-based uses only manufacturing activities).

3. The post-purchase costs for Design A would be $240 ($230 + $10) and for Design B would be $247 ($197 + $50). Design A is the cheaper of the two designs when post-purchase costs are considered.

Role of Target Costing

Life-cycle cost management emphasizes cost reduction, not cost control. Target costing becomes a particularly useful tool for establishing cost reduction goals during the design stage. A **target cost** is the difference between the sales price needed to capture a predetermined market share and the desired per-unit profit. The sales price reflects the product specifications or functions valued by the customer (referred to as *product functionality*). If the target cost is less than what is currently achievable, then management must find cost reductions that move the actual cost toward the target cost. Finding those cost reductions is the principal challenge of target costing.

Three cost reduction methods are typically used: (1) reverse engineering, (2) value analysis, and (3) process improvement. In reverse engineering, the competitors' products are closely analyzed (a "tear down" analysis) in an attempt to discover more

design features that create cost reductions. Value analysis attempts to assess the value placed on various product functions by customers. If the price customers are willing to pay for a particular function is less than its cost, the function is a candidate for elimination. Another possibility is to find ways to reduce the cost of providing the function (e.g., using common components). Both reverse engineering and value analysis focus on product design to achieve cost reductions. The processes used to produce and market the product are also sources of potential cost reductions. Thus, redesigning processes to improve their efficiency can also contribute to achieving the needed cost reductions. The target-costing model is summarized in Exhibit 13-8.

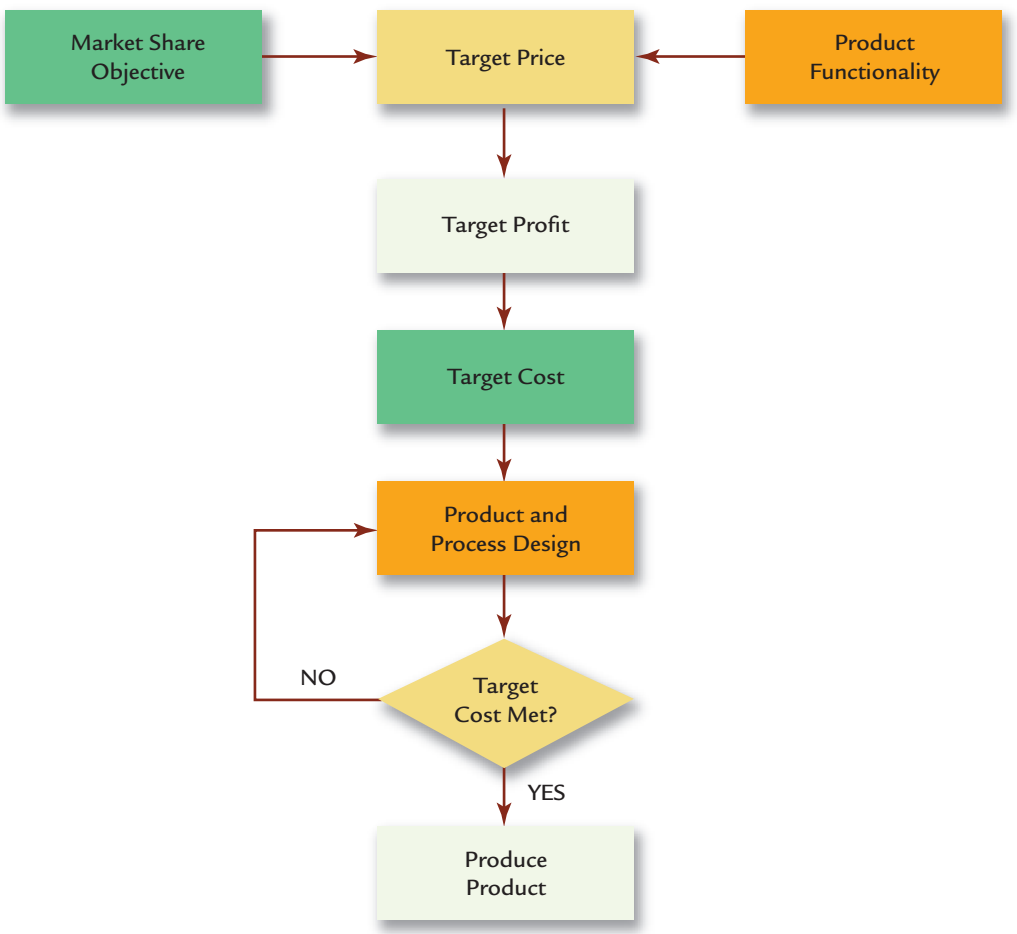
A simple example can be used to illustrate the concepts described by Exhibit 13-8. Assume that a company is considering the production of a new trencher. Current product specifications and the targeted market share call for a sales price of $250,000. The required profit is $50,000 per unit. The target cost is computed as follows:

$$\begin{aligned}\text{Target cost} &= \$250{,}000 - \$50{,}000\\ &= \$200{,}000\end{aligned}$$

It is estimated that the current product and process designs will produce a cost of $225,000 per unit. Thus, the cost reduction needed to achieve the target cost and desired profit is $25,000 ($225,000 − $200,000). A tear-down analysis of a competitor's trencher revealed a design improvement that promised to save $5,000 per unit. When compared with the $25,000 reduction needed, additional effort was still

Exhibit 13-8

Target-Costing Model



necessary. A marketing study of customer reactions to product functions revealed that the extra trenching speed in the new design was relatively unimportant. Changing the design to reflect a lower trenching speed saved $10,000. The company's supplier also proposed the use of a standardized component, reducing costs by another $5,000. Finally, the design team was able to change the process design and reduce the test time by 50 percent. This saved $6,000 per unit. The last change reached the threshold value, and production for the new model was approved.

Target costs are a type of currently attainable standard. But they are conceptually different from traditional standards. What sets them apart is the motivating force. Traditional standards are internally motivated and set, based on concepts of efficiency developed by industrial engineers and production managers. Target costs, on the other hand, are externally driven, generated by an analysis of markets and competitors.

Supplier and Firm Interaction The example just given indicated that one source of cost reduction came from a supplier suggestion. During the design stage, target costing requires a close interaction between the firm and its suppliers. This interaction should produce lower cost solutions than would be possible if the design teams acted in isolation.[11] Joint design efforts require cooperative relationships. Incentives for such relationships come from a willingness to search for mutually beneficial solutions.

Short Life Cycles Although life-cycle cost management is important for all manufacturing firms, it is particularly important for firms that have products with short life cycles. Products must recover all life-cycle costs and provide an acceptable profit. If a firm's products have long life cycles, profit performance can be increased by such actions as redesigning, changing prices, reducing costs, and altering the product mix. In contrast, firms that have products with short life cycles usually do not have time to react in this way so their approach must be proactive. Thus, for short life cycles, good life-cycle planning is critical, and prices must be set properly to recover all the life-cycle costs and provide a good return. Activity-based costing can be used to encourage good life-cycle planning. By careful selection of cost drivers, design engineers can be motivated to choose cost-minimizing designs.

OBJECTIVE 4
Identify the basic features of JIT purchasing and manufacturing.

Just-in-Time (JIT) Manufacturing and Purchasing

JIT manufacturing and purchasing systems offer a prominent example of how managers can use the strategic concepts discussed earlier in the chapter to bring about significant changes within an organization. Firms that implement JIT are pursuing a cost reduction strategy by redefining the structural and procedural activities performed within an organization. Cost reduction is supportive of either a cost leadership or differentiation strategy. Cost reduction is directly related to cost leadership. Successful differentiation depends on offering greater value; yet this value added must be more than the cost of providing it. JIT can help add value by reducing waste. Successful implementation of JIT has brought about significant improvements, such as better quality, increased productivity, reduced lead times, major reductions in inventories, reduced setup times, lower manufacturing costs, and increased production rates. JIT techniques have been implemented by the following companies with meaningful results:

[11] Robin Cooper and Regine Slagmulder, "Cost Management Beyond the Boundaries of the Firm," *Management Accounting* (March 1998): 18–20.

AT&T	General Electric	Motorola
Black & Decker	Harley-Davidson	Toys "R" Us
Canada Safeway	Hewlett-Packard	Wal-Mart
Chrysler	Intel	Westinghouse
Ford	John Deere	Xerox

Adopting a JIT manufacturing system has a significant effect on the nature of the cost management accounting system. Installing a JIT system affects the traceability of costs, enhances product costing accuracy, diminishes the need for allocation of service-centre costs, changes the behaviour and relative importance of direct labour costs, impacts job-order and process-costing systems, decreases the reliance on standards and variance analysis, and decreases the importance of inventory tracking systems. To understand and appreciate these effects, we need a fundamental understanding of what JIT manufacturing is and how it differs from traditional manufacturing.

JIT manufacturing is a demand-pull system. The objective of **JIT manufacturing** is to eliminate waste by producing a product only when it is needed and only in the quantities demanded by customers. Demand pulls products through the manufacturing process. Each operation produces only what is necessary to satisfy the demand of the succeeding operation. No production takes place until a signal from a succeeding process indicates a need to produce. Parts and materials arrive just in time to be used in production. JIT assumes that all costs other than direct materials are driven by time and space drivers. JIT then focuses on eliminating waste by compressing time and space.

Inventory Effects

Usually, the push-through system produces significantly higher levels of finished goods inventory than does a JIT system. JIT manufacturing relies on the exploitation of a customer linkage. Specifically, production is tied to customer demand. This linkage extends back through the value chain and also affects how a manufacturer deals with suppliers. **JIT purchasing** requires suppliers to deliver parts and materials just in time to be used in production. Thus, supplier linkages are also vital. Supply of parts must be linked to production, which is linked to demand. One effect of successful exploitation of these linkages is to reduce all inventories to much lower levels. Since 1980, inventories have dropped dramatically in both Canada and the United States relative to gross domestic product.

Traditionally, inventories of raw materials and parts are carried so that a firm can take advantage of quantity discounts and hedge against future price increases of the items purchased. The objective is to lower the cost of inventory. JIT achieves the same objective without carrying inventories. The JIT solution is to exploit supplier linkages by negotiating long-term contracts with a few chosen suppliers located as close to the production facility as possible and by establishing more extensive supplier involvement. Suppliers are not selected on the basis of price alone.

Performance—the quality of the component and the ability to deliver as needed—and commitment to JIT purchasing are vital considerations. Every effort is made to establish a partners-in-profits relationship with suppliers. Suppliers need to be convinced that their well-being is intimately tied to the well-being of the buyer.

To help reduce the uncertainty in demand for the supplier and establish the mutual confidence and trust needed in such a relationship, JIT manufacturers emphasize long-term contracts. Other benefits of long-term contracts exist. They stipulate prices and acceptable quality levels. Long-term contracts also reduce dramatically the number of orders placed, which helps to drive down the ordering and receiving costs. Another effect of long-term contracting is a reduction in the cost of parts and materials—usually in the range of 5 percent to 20 percent less than what was paid in a traditional setting.

The need to develop close supplier relationships often drives the supplier base down dramatically.

For example, **Mercedes-Benz U.S. International**'s factory in Vance, Alabama, saved time and money by streamlining its supplier list from 1,000 to 100 primary suppliers. In exchange for annual 5 percent price cuts, the chosen suppliers have multiyear contracts (as opposed to the yearly bidding process practised at other Mercedes' plants) and can adapt off-the-shelf parts to Mercedes' needs. The end result is lower costs for both Mercedes and its suppliers.[12]

Suppliers also benefit. The long-term contract ensures a reasonably stable demand for their products. A smaller supplier base typically means increased sales for the selected suppliers. Thus, both buyers and suppliers benefit—a common outcome when external linkages are recognized and exploited.

By reducing the number of suppliers and working closely with those that remain, the quality of the incoming materials can be improved significantly—a crucial outcome for the success of JIT. As the quality of incoming materials increases, some quality-related costs can be avoided or reduced. For example, the need to inspect incoming materials disappears, and rework requirements decline.

Plant Layout

The type and efficiency of plant layout is another executional cost driver that is managed differently under JIT manufacturing. In traditional job and batch manufacturing, products are moved from one group of identical machines to another. Typically, machines with identical functions are located together in an area referred to as a *department* or *process*. Workers who specialize in the operation of a specific machine are located in each department. Thus, the executional cost driver for a traditional setting is departmental structure. JIT replaces this traditional plant layout with a pattern of manufacturing cells. The executional cost driver for a JIT setting is cell structure. Cell structure is chosen over departmental structure because it increases the ability of the organization to "execute" successfully. The cellular manufacturing design can also affect structural activities, such as plant size and number of plants, because it typically requires less space. Space savings can reduce the demand to build new plants and will affect the size of new plants when they are needed.

Manufacturing cells contain machines that are grouped into families, usually in a semicircle. The machines are arranged so that they can be used to perform a variety of operations in sequence. Each cell is set up to produce a particular product or product family. Products move from one machine to another from start to finish. Workers are assigned to cells and are trained to operate all machines within the cell. In other words, labour in a JIT environment is multiskilled, not specialized. Each manufacturing cell is essentially a minifactory; in fact, a cell is often referred to as a *factory within a factory*.

Grouping of Employees

Another major structural difference between JIT and traditional organizations relates to how employees are grouped. As just indicated, each cell is viewed as a mini-factory; thus, each cell requires easy and quick access to support services, which means that centralized service departments must be scaled down and their personnel reassigned to work directly with manufacturing cells. For example, with respect to raw materials, JIT calls for multiple stock points, each one located near where the material will be used. There is no need for a central store location—in fact, such an arrangement actually hinders efficient production. A purchasing agent can be assigned to each cell to handle material requirements. Similarly, other service personnel, such as manufacturing and quality engineers, can be assigned to cells.

Other support services may be relocated to the cell by training cell workers to perform the services. For example, in addition to direct production work, cell workers may perform setup duties, move partially completed goods from station to station

[12] David Woodruff and Karen Lowry Miller, "Mercedes' Maverick in Alabama," *BusinessWeek* (September 11, 1995): 64–65.

within the cell, perform preventive maintenance and minor repairs, conduct quality inspections, and perform janitorial tasks. This multiple task capability is directly related to the pull-through production approach. Producing on demand means that production workers (formerly direct labourers) may often have "free" time. This non-production time can be used to perform some of the other support activities.

Employee Empowerment

A major procedural difference between traditional and JIT environments is the degree of participation allowed workers in the management of the organization. According to the JIT view, increasing the degree of participation (the executional cost driver) increases productivity and overall cost efficiency. Workers are allowed a say in how the plant operates. For example, workers are allowed to shut down production to identify and correct problems. Managers seek workers' input and use their suggestions to improve production processes. Workers are often involved in interviewing and hiring other employees, sometimes even prospective bosses. The reason? If the "chemistry is right," then the workforce will be more efficient, and they will work together better.

Employee empowerment, a procedural activity, also affects other structural and procedural activities. The management structure must change in response to greater employee involvement. Because workers assume greater responsibilities, fewer managers are needed, and the organizational structure becomes flatter. Flatter structures speed up and increase the quality of information exchange. The style of management needed in the JIT firm also changes. Managers in the JIT environment need to act as facilitators more than as supervisors. Their role is to develop people and their skills so that they can make value-adding contributions.

Total Quality Management

JIT necessarily carries with it a much stronger emphasis on managing quality. A defective part brings production to a grinding halt. Poor quality simply cannot be tolerated in a manufacturing environment that operates without inventories. Simply put, JIT cannot be implemented without a commitment to total quality management (TQM). TQM is essentially a never-ending quest for perfect quality: the striving for a defect-free product design and manufacturing process. This approach to managing quality is diametrically opposed to the traditional doctrine, called **acceptable quality level (AQL)**. AQL permits or allows defects to occur provided they do not exceed a predetermined level.

The major differences between JIT manufacturing and traditional manufacturing are summarized in Exhibit 13-9. These differences will be referred to and discussed in greater detail as the implications of JIT manufacturing for cost management are examined.

Exhibit 13-9

Comparison of JIT Approaches with Traditional Manufacturing and Purchasing

JIT	Traditional
1. Pull-through system	1. Push-through system
2. Insignificant inventories	2. Significant inventories
3. Small supplier base	3. Large supplier base
4. Long-term supplier contracts	4. Short-term supplier contracts
5. Cellular structure	5. Departmental structure
6. Multiskilled labour	6. Specialized labour
7. Decentralized services	7. Centralized services
8. High employee involvement	8. Low employee involvement
9. Facilitating management style	9. Supervisory management style
10. Total quality management	10. Acceptable quality level
11. Buyers' market	11. Sellers' market
12. Value-chain focus	12. Value-added focus

OBJECTIVE 5
Describe the effect JIT has on cost traceability and product costing.

JIT and Its Effect on the Cost Management System

The numerous changes in structural and procedural activities that we have described for a JIT system also change traditional cost management practices. Both the cost accounting and operational control systems are affected. In general, the organizational changes simplify the cost management accounting system and simultaneously increase the accuracy of the cost information being produced.

Traceability of Overhead Costs

Costing systems use three methods to assign costs to individual products: direct tracing, driver tracing, and allocation. Of the three methods, the most accurate is direct tracing; for this reason, it is preferred over the other two methods. In a JIT environment, many overhead costs assigned to products using either driver tracing or allocation are now directly traceable to products. Cellular manufacturing, multiskilled labour, and decentralized service activities are the major features of JIT responsible for this change in traceability.

In a departmental structure, many different products may be subjected to a process located in a single department (e.g., Grinding). After completion of the process, the products are then transferred to other processes located in different departments (e.g., Assembly, Painting, and so on). Although a different set of processes is usually required for each product, most processes are applicable to more than one product. For example, 30 different products may need grinding. Because more than one product is processed in a department, the costs of that department are common to all products passing through it, and therefore the costs must be assigned to products using activity drivers or allocation. In a manufacturing-cell structure, however, all processes necessary for the production of each product or major subassembly are collected in one area called a cell. Thus, the costs of operating that cell can be assigned to the cell's product or subassembly using direct tracing. (However, if a family of products uses a cell, then we must resort to drivers and allocation to assign costs.)

Equipment formerly located in other departments, for example, is now reassigned to cells, where it may be dedicated to the production of a single product or subassembly. In this case, depreciation is now a directly attributable product cost. Multiskilled workers and decentralized services add to the effect. Workers in the cell are trained to set up the equipment in the cell, maintain it, and operate it. Additionally, cell workers may also be used to move a partially finished part from one machine to the next or to perform maintenance, setups, and materials handling. These support functions were previously done by a different set of labourers for all product lines. Additionally, people with specialized skills (e.g., industrial engineers and production schedulers) are assigned directly to manufacturing cells. Because of multitask assignments and redeployment of other support personnel, many support costs can now be assigned to a product using direct tracing. Exhibit 13-10 compares the traceability of some selected costs in a traditional manufacturing environment with their traceability in the JIT environment (assuming single-product cells). Comparisons are based on the three cost assignment methods.

Product Costing

One consequence of increasing directly attributable costs is to increase the accuracy of product costing. Directly traceable costs are associated (usually by physical observation) with the product and can safely be said to belong to it. Other costs, however, are common to several products and must be assigned to these products using activity drivers and allocation. Because of cost and convenience, activity drivers that are less than perfectly correlated with the consumption of overhead activities may be chosen. JIT manufacturing reduces the need for this difficult assessment by converting many common costs to directly attributable costs. Note, however, that the driving force behind these changes is not the cost management system itself but the changes in the structural and procedural activities brought about by implementing a JIT system.

Exhibit 13-10

Product Cost Assignment: Traditional versus JIT Manufacturing

Manufacturing Cost	Traditional Environment	JIT Environment
Direct labour	Direct tracing	Direct tracing
Direct materials	Direct tracing	Direct tracing
Materials handling	Driver tracing	Direct tracing
Repairs and maintenance	Driver tracing	Direct tracing
Energy	Driver tracing	Direct tracing
Operating supplies	Driver tracing	Direct tracing
Supervision (department)	Allocation	Direct tracing
Insurance and taxes	Allocation	Allocation
Plant depreciation	Allocation	Allocation
Equipment depreciation	Driver tracing	Direct tracing
Custodial services	Allocation	Direct tracing
Cafeteria services	Driver tracing	Driver tracing

While activity-based costing offers significant improvement in product costing accuracy, focusing on structural and procedural activities offers even more potential improvement.

Exhibit 13-10 illustrates that JIT does not convert all costs into directly traceable costs. Even with JIT in place, some overhead activities remain common to the manufacturing cells. These remaining support activities are mostly facility-level activities. In a JIT system, the batch size is one unit of product. Thus, all batch-level activities convert into unit-level activities. Additionally, many of the batch-level activities are reduced or eliminated. For example, materials handling may be significantly reduced because of the reorganization from a departmental structure to a cellular structure. Similarly, for single-product cells, there is no setup activity. Even for cells that produce a family of products, setup times would be minimal. Furthermore, it is likely that the need to use activity drivers for the cost of product-level activities is significantly diminished because of decentralizing these support activities to the cell level. Is there, then, a role for ABC in a JIT firm?

Although JIT diminishes the value of ABC for tracing manufacturing costs to individual products, an activity-based costing system has much broader application than just tracing manufacturing costs to products. For many strategic and tactical decisions, the product cost definition needs to include nonmanufacturing costs. For example, value-line and operational product costing is an invaluable tool for strategic costing analysis and for life-cycle cost management. Also, including post-purchase costs as part of the product cost definition provides valuable insights. Thus, knowing and understanding general and administrative, research, development, marketing, customer service, and post-purchase activities and their cost drivers is essential for sound cost analysis. Furthermore, as we have already seen, using ABC to assign costs accurately to suppliers and customers is an essential part of strategic cost management.

JIT's Effect on Job-Order and Process-Costing Systems

In implementing JIT in a job-order setting, the firm should first separate its repetitive business from its unique orders. Manufacturing cells can then be established to deal with the repetitive business. For those products where demand is insufficient to justify their own manufacturing cells, groups of dissimilar machines can be set up in a cell to make families of products or parts that require the same manufacturing sequence.

With this reorganization of the manufacturing layout, job orders are no longer needed to accumulate product costs. Instead, costs can be accumulated at the cellular level. Additionally, because lot sizes are now too small (as a result of reducing work-in-process and finished goods inventories), it is impractical to have job orders for each job. Add to this the short lead time of products because of the time and space

compression features of JIT (virtually no setup time and cellular structures), and it becomes difficult to track each piece moving through the cell. In effect, the job environment has taken on the nature of a process-costing system.

JIT simplifies process costing. A key feature of JIT is lower inventories. Assuming that JIT is successful in reducing work in process, the need to compute equivalent units vanishes. Calculating product costs follows the simple pattern of collecting costs for a cell for a period of time and dividing the costs by the units produced for that period.

Backflush Costing

The JIT system also offers the opportunity to simplify the accounting for manufacturing cost flows. Given low inventories, it may not be desirable to spend resources tracking the cost flows through all the inventory accounts. In a traditional system, there was a work-in-process account for each department so that manufacturing costs could be traced as work proceeded through the factory. Under JIT, there are no departments, a 14-day lead time (for example) has been decreased to four hours, and it would be absurd to trace costs from station to station within a cell. After all, if production cycle time is in minutes or hours, and goods are shipped immediately upon completion, then all of each day's manufacturing costs flow to Cost of Goods Sold. Recognizing this outcome leads to a simplified approach to accounting for manufacturing cost flows. This simplified approach, called **backflush costing**, uses trigger points to determine when manufacturing costs are assigned to key inventory and temporary accounts.

Varying the number and location of trigger points creates several types of backflush costing. Trigger points are simply events that prompt ("trigger") the accounting recognition of certain manufacturing costs. There are four variations, depending on the definition of the trigger points (which, in turn, depends on how fully the firm has implemented JIT):

1. The purchase of raw materials (trigger point 1) and the completion of goods (trigger point 2).
2. The purchase of raw materials (trigger point 1) and the sale of goods (trigger point 2).
3. The completion of goods (only trigger point).
4. The sale of goods (only trigger point).

Variations 1 and 2 For Variations 1 and 2, the first trigger point is the purchase of raw materials. When materials are purchased in a JIT system, they are immediately placed into process. Raw Materials and In Process Inventory (WIP) is debited, and Accounts Payable is credited. The inventory account is used only for tracking the cost of raw materials. There is no separate materials inventory account and no work-in-process inventory account. Combining direct labour and overhead into one category is a second feature of backflush costing. As firms implement JIT and become automated, the traditional direct labour cost category disappears. Multiskilled workers perform setup activities, machine-loading activities, maintenance, materials handling, and so on. As labour becomes multifunctional, the ability to track and report direct labour separately becomes impossible. Consequently, backflush costing usually combines direct labour costs with overhead costs in a temporary account called *Conversion Cost Control*. This account accumulates the *actual* conversion costs on the debit side and the applied conversion costs on the credit side. Any difference between the actual conversion costs and the applied conversion costs is closed to Cost of Goods Sold.

In the first variant of backflush costing, the completion of goods triggers the recognition of the manufacturing costs used to produce the goods (the second trigger point). At this point, conversion cost application is recognized by debiting Finished Goods Inventory and crediting Conversion Cost Control; the cost of direct materials is recognized by debiting Finished Goods Inventory and crediting the WIP inventory account. Therefore, the costs of manufacturing are "flushed" out of the system after the goods are completed.

In the second variant of backflush costing, the second trigger point is defined by the point when goods are sold rather than when they are completed. For this variant, the costs of manufacturing are flushed out of the system *after* the goods are sold. Thus, the application of conversion cost and the transfer of direct materials cost are accomplished by debiting Cost of Goods Sold and crediting Conversion Cost Control and WIP Inventory, respectively. Other entries are the same as Variation 1.

Variations 3 and 4 Under Variations 3 and 4, there is only one trigger point. Both variations recognize actual conversion costs by debiting Conversion Cost Control and crediting various accounts (such as Accumulated Depreciation). Neither variation makes any entry for the purchase of raw materials. For Variation 3, when the goods are completed, all costs, including direct materials cost, are flushed out of the system. This is done by debiting Finished Goods Inventory for the cost of all manufacturing inputs and crediting Accounts Payable for the cost of direct materials and Conversion Cost Control for the application of conversion costs. For Variation 4, the costs are flushed out of the system when the goods are sold. Thus, Cost of Goods Sold is debited, and Accounts Payable and Conversion Cost Control are credited. Of the four variations, only Variation 4 avoids all inventory accounts and, thus, would be the approach used for a pure JIT firm. Cornerstone 13-5 illustrates backflush costing.

The HOW and WHY of Backflush Costing

CORNERSTONE 13-5

Information:

A JIT company had the following transactions during June:

1. Purchased raw materials on account for $160,000.
2. Placed all materials received into production.
3. Incurred actual direct labour costs of $25,000.
4. Incurred actual overhead costs of $225,000.
5. Applied conversion costs of $235,000 ($25,000 of direct labour + $210,000 of applied overhead).
6. Completed all work for the month.
7. Sold all completed work.
8. Computed the difference between actual and applied costs.

Why:

Reduced cycle time and immediate shipping of goods simplifies accounting for manufacturing cost flows. How simplified depends on the completeness of the JIT system (measured by "trigger points").

Required:

1. Prepare the journal entries for traditional and backflush costing. For backflush costing, assume there are two trigger points: (1) the purchase of raw materials and (2) the completion of the goods.
2. Assume the second trigger point in Requirement 1 is the sale of goods. What would change for the backflush costing journal entries?
3. ***What if*** there is only one trigger point and it is (a) completion of the goods or (b) sale of goods? How would the backflush costing journal entries differ from Requirement 1 for (a) and (b)?

CORNERSTONE 13-5 *(continued)*

Solution:

1.

Transaction	Traditional Journal Entries			Backflush Journal Entries: Variation 1		
1. Purchase of raw materials	Materials Inventory	160,000		Raw Materials and In Process Inventory	160,000	
	Accounts Payable		160,000	Accounts Payable		160,000
2. Materials issued to production	Work-in-Process Inventory	160,000		No entry		
	Materials Inventory		160,000			
3. Direct labour cost incurred	Work-in-Process Inventory	25,000		Combined with overhead: See next entry.		
	Wages Payable		25,000			
4. Overhead cost incurred	Overhead Control	225,000		Conversion Cost Control	250,000	
	Accounts Payable		225,000	Wages Payable		25,000
				Accounts Payable		225,000
5. Application of overhead	Work-in-Process Inventory	210,000		No entry		
	Overhead Control		210,000			
6. Completion of goods	Finished Goods Inventory	395,000		Finished Goods Inventory	395,000	
	Work-in-Process Inventory		395,000	Raw Materials and In Process Inventory		160,000
				Conversion Cost Control		235,000
7. Goods are sold	Cost of Goods Sold	395,000		Cost of Goods Sold	395,000	
	Finished Goods Inventory		395,000	Finished Goods Inventory		395,000
8. Variance is recognized	Cost of Goods Sold	15,000		Cost of Goods Sold	15,000	
	Overhead Control		15,000	Conversion Cost Control		15,000

2. The entries for Transactions 6 and 7 in Requirement 1 are replaced with the following entry:

Cost of Goods Sold	395,000	
Raw Materials and In Process Inventory		160,000
Conversion Cost Control		235,000

All other entries follow those in Requirement 1.

3. (a) There is no entry for Transaction 1. Transaction 6 is replaced with the following entry:

CORNERSTONE 13-5 (continued)

Finished Goods Inventory	395,000	
Accounts Payable		160,000
Conversion Cost Control		235,000

(b) There is no entry for Transaction 1. Transactions 6 and 7 are replaced with the following entry:

Cost of Goods Sold	395,000	
Accounts Payable		160,000
Conversion Cost Control		235,000

Summary of Learning Objectives

1. Explain what strategic cost management is and how it can be used to help a firm create a competitive advantage.

- Obtaining a competitive advantage so that long-term survival is ensured is the goal of strategic cost management.
- Different strategies create different bundles of activities. By assigning costs to activities, the costs of different strategies can be assessed.
- There are three generic or general strategies: cost leadership, differentiation, and focusing. The particular mix and relative emphasis of these three strategies define a firm's strategic position.
- The objective of strategic cost management is to reduce costs while simultaneously strengthening a firm's strategic position.

2. Discuss value-chain analysis and the strategic role of activity-based customer and supplier costing.

- Knowledge of organizational and operational activities and their associated cost drivers is fundamental to strategic cost analysis. Knowledge of the firm's value chain and the industrial value chain is also critical.
- Value-chain analysis relies on identifying and exploiting internal and external linkages.
- Good cost management of supplier and customer linkages requires an understanding of what suppliers cost and how much it costs to service customers.
- Activity-based assignments to suppliers and customers provide the accurate cost information needed.

3. Tell what life-cycle cost management is and how it can be used to maximize profits over a product's life cycle.

- Life-cycle cost management is related to strategic cost analysis and, in fact, could be called a type of strategic cost analysis.
- Life-cycle cost management requires an understanding of the three types of life-cycle viewpoints: the marketing viewpoint, the production viewpoint, and the consumable life viewpoint.

- Target costing plays an essential role in life-cycle cost management by providing a methodology for reducing costs in the design stage by considering and exploiting both customer and supplier linkages.

4. Identify the basic features of JIT purchasing and manufacturing.

- JIT purchasing and manufacturing offer a totally different set of structural and procedural activities from those of the traditional organization.
- In JIT purchasing, parts and materials arrive just in time to be used in production. JIT assumes that all costs other than direct materials are driven by time and space drivers.
- Understanding supplier and customer linkages is vital for a successful JIT system.

5. Describe the effect JIT has on cost traceability and product costing.

- In a JIT environment, many overhead costs assigned to products using either driver tracing or allocation are now directly traceable to products.
- A vastly simplified process costing system is the usual structure for a JIT environment.
- Product costing is more accurate because of increased traceability of costs.
- Accounting for the cost accounting cycle is simplified using backflush costing.

CORNERSTONES FOR CHAPTER 13

Review Problems

I. Strategic Cost Management, Target Costing

Assume that a firm has the following activities and associated cost behaviours:

Activities	Cost Behaviour
Assembling components	$10 per direct labour hour
Setting up equipment	Variable: $100 per setup
	Step-fixed: $30,000 per step, 1 step = 10 setups
Receiving goods	Step-fixed: $40,000 per step, 1 step = 2,000 hours

Activities with step-cost behaviour are being fully utilized by existing products. Thus, any new product demands will increase resource spending on these activities.

Two designs are being considered for a new product: Design I and Design II. The following information is provided about each design (1,000 units of the product will be produced):

Activity Driver	Design I	Design II
Direct labour hours	3,000	2,000
Number of setups	10	20
Receiving hours	2,000	4,000

The company has recently developed a cost equation for manufacturing costs using direct labour hours as the driver. The equation has $R^2 = 0.60$ and is as follows:

$$Y = \$150{,}000 + \$20X$$

Required:

1. Suppose that the firm's design engineers are told that only direct labour hours drive manufacturing costs (based on the direct labour cost equation). Compute the cost of each design. Which design would be chosen based on this unit-based cost assumption?
2. Now compute the cost of each design using all driver and activity information. Which design will now be chosen? Are there any other implications associated with the use of the more complete activity information set?
3. Consider the following statement: "Strategic cost analysis should exploit internal linkages." What does this mean? Explain, using the results of Requirements 1 and 2.
4. An outside consultant indicated that target costing ought to be used in the design stage. Explain what target costing is, and describe how it requires an understanding of both supplier and customer linkages.
5. What other information would be useful to have concerning the two designs? Explain.

Solution:

1. Design I: $\$20 \times 3{,}000 = \$60{,}000 + \$150{,}000 = \$210{,}000$
   Design II: $\$20 \times 2{,}000 = \$40{,}000 + \$150{,}000 = \$190{,}000$
   The unit-based analysis would lead to the selection of Design II.
2. Design I:

Assembling components ($10 × 3,000)	$ 30,000
Setting up equipment [(10 × $100) + (1 × $30,000)]	31,000
Receiving goods (1 × $40,000)	40,000
Total	$101,000

Design II:

Assembling components ($10 × 2,000)	$ 20,000
Setting up equipment [(20 × $100) + (2 × $30,000)]	62,000
Receiving goods (2 × $40,000)	80,000
Total	$162,000

Design I has the lowest total cost. Notice also the difference in expected total manufacturing costs. The direct labour driver approach produces a much higher cost for both designs. This difference in cost could produce significant differences in pricing strategies.

3. Exploiting internal linkages means taking advantage of the relationships among the activities that exist within a firm's segment of the value chain. To do this, we must know what the activities are and how they are related. Activity costs and drivers are an essential part of this analysis. Using only unit-based drivers for design decisions, as in Requirement 1, ignores the effect that different designs have on non-unit-based activities. The results of Requirement 2 illustrate a significant difference between two designs—relative to the unit-based analysis. The traditional costing system simply is not rich enough to supply the information needed for a thorough analysis of linkages.
4. Target costing specifies the unit cost required to achieve a given share of the market for a product with certain functional specifications. This target cost is then compared with the expected unit cost. If the expected unit cost is greater than the target cost, then actions are taken to reduce the costs to the desired level. Three general methods of cost reduction are used: (1) tear-down engineering, (2) value analysis, and (3) process improvement. Tear-down engineering dismantles competitors' products to search for more efficient product designs. Value engineering evaluates customer reactions to proposed functions and determines whether they are worth

the cost to produce. Process improvement seeks to improve the efficiency of the process that will be used to produce the new product. The first two methods are concerned with improving product design, while the third is concerned with improving process design. Involving both customers and suppliers in the process has the objective of producing lower costs than would be obtained if the design team worked in isolation. Suppliers, for example, may suggest alternative designs that will reduce the cost of the components that go into the product. Customers, of course, can indicate whether they value a particular design feature and, if so, how much they would be willing to pay for it.

5. Linkages also extend to the rest of the firm's internal value-chain activities. It would be useful to know how design choices affect, and are affected by, logistical activities. External linkages would also help. For example, it would be interesting to know how post-purchase activities and costs are affected by the two designs.

II. Backflush Costing

Foster Company has implemented a JIT system and is considering the use of backflush costing. Foster had the following transactions for the first quarter of the current fiscal year. (Conversion cost variances are recognized quarterly.)

1. Purchased raw materials on account for $400,000.
2. Placed all materials received into production.
3. Incurred actual direct labour costs of $60,000.
4. Incurred actual overhead costs of $400,000.
5. Applied conversion costs of $470,000.
6. Completed all work for the month.
7. Sold all completed work.
8. Computed the difference between actual and applied costs.

Required:

Prepare journal entries for Variations 2 and 4 of backflush costing.

Solution:

	Transaction	Backflush Journal Entries: Variation 2		
1.	Purchase of raw materials	Raw Materials and In Process Inventory	400,000	
		Accounts Payable		400,000
4.	Overhead cost incurred	Conversion Cost Control	460,000	
		Wages Payable		60,000
		Accounts Payable		400,000
7.	Goods are sold	Cost of Goods Sold	870,000	
		Raw Materials and In Process Inventory		400,000
		Conversion Cost Control		470,000
8.	Variance is recognized	Conversion Cost Control	10,000	
		Cost of Goods Sold		10,000

	Transaction	Backflush Journal Entries: Variation 4		
4.	Overhead cost incurred	Conversion Cost Control	460,000	
		Wages Payable		60,000
		Accounts Payable		400,000

	Transaction	Backflush Journal Entries: Variation 4		
7.	Goods are sold	Cost of Goods Sold	870,000	
		Accounts Payable		400,000
		Conversion Cost Control		470,000
8.	Variance is recognized	Conversion Cost Control	10,000	
		Cost of Goods Sold		10,000

Key Terms

Acceptable quality level (AQL), 667
Backflush costing, 670
Competitive advantage, 644
Consumable life, 657
Cost leadership strategy, 645
Customer value, 644
Decline stage, 657
Differentiation strategy, 645
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Strategic positioning, 645
Strategy, 645
Structural activities, 647
Target cost, 662
Total product, 644
Total quality management (TQM), 652
Value-chain analysis, 644

Discussion Questions

1. What does it mean to obtain a competitive advantage? What role does the cost management system play in helping to achieve this goal?
2. What is customer value? How is customer value related to a cost leadership strategy? To a differentiation strategy? To strategic positioning?
3. Explain what internal and external linkages are.
4. What are organizational and operational activities? Organizational cost drivers? Operational cost drivers?
5. What is the difference between a structural cost driver and an executional cost driver? Provide examples of each.
6. What is value-chain analysis? What role does it play in strategic cost analysis?
7. What is an industrial value chain? Explain why a firm's strategies are tied to what happens in the rest of the value chain. Using total quality management as an example, explain how the success of this quality management approach is dependent on supplier linkages.
8. What are the three viewpoints of product life cycle? How do they differ?
9. What are the four stages of the marketing life cycle?
10. What are life-cycle costs? How do these costs relate to the production life cycle?
11. What are the four stages of the consumption life cycle? What are post-purchase costs? Explain why a producer may want to know post-purchase costs.
12. "Life-cycle cost reduction is best achieved during the development stage of the production life cycle." Do you agree or disagree? Explain.

13. What is target costing? What role does it have in life-cycle cost management?
14. Explain why JIT with dedicated cellular manufacturing increases product costing accuracy.
15. Explain how backflush costing works.

Cornerstone Exercises

OBJECTIVE 2
CORNERSTONE 13-1

Cornerstone Exercise 13-1 EXPLOITING INTERNAL LINKAGES

Thomas Inc. is currently producing a motorcycle that uses five specialized parts. Engineering has proposed replacing these specialized parts with commodity parts, which will cost less and can be purchased in larger order quantities. Current activity capacity and demand (with specialized parts required) and expected activity demand (with only commodity parts required) are provided.

Activities	Activity Driver	Activity Capacity	Current Activity Demand	Expected Activity Demand
Material usage	Number of parts	320,000	320,000	320,000
Installing parts	Direct labour hours	150,000	150,000	120,000
Purchasing parts	Number of orders	30,000	28,500	17,500

Additionally, the following activity cost data are provided:

Material usage: $40 per specialized part used; $20 per commodity part; no fixed activity cost.
Installing parts: $15 per direct labour hour; no fixed activity cost.
Purchasing parts: Five salaried clerks, each earning a $40,000 annual salary; each clerk is capable of processing 6,000 purchase orders. Variable activity costs: $0.75 per purchase order processed for forms, postage, etc.

Required:

1. Calculate the cost reduction produced by using commodity parts instead of specialized parts.
2. Suppose that 64,000 units are being produced and sold for $9,000 per unit and that the price per unit will be reduced by the per-unit savings. What is the new price for the configured product?
3. ***What if*** the expected activity demand for purchase orders was 11,500? How would this affect the answers to Requirements 1 and 2?

OBJECTIVE 2
CORNERSTONE 13-2
SERVICE

Cornerstone Exercise 13-2 ACTIVITY-BASED SUPPLIER COSTING

Vidrio Company is a car window repair and replacement company operating in the after-sales market. Vidrio's purchasing manager uses two suppliers (Smith Glass and Wolf Glass) for the source of its passenger car windows. Data relating to side windows (Side) and windshields (WS) are given below.

I. Activity Costs

Activity	
Adverse buying*	$350,000
Supplier returns**	60,000

*Extra cost of purchasing from local car dealer because of insufficient delivery of supplier.
**Windows returned because they were not ordered or because they were defective.

II. Supplier Data

	Smith Glass		Wolf Glass	
	Side	WS	Side	WS
Unit purchase price	$47	$113	$45	$110
Units purchased	10,000	10,000	20,000	20,000
Insufficient units	500	500	2,000	2,000
Returned units	250	250	1,000	1,000

Required:

1. Calculate the activity rates for assigning costs to suppliers.
2. Calculate the total unit purchasing cost for each component for each supplier.
3. ***What if*** the quantity of side windows that can be purchased is limited to 10,000 units from Smith and 30,000 units from Wolf? There is no limit from either source for windshields. Based on cost, what purchasing mix should be chosen? What problem does this create? What else might you suggest if you were the manager of Vidrio?

Cornerstone Exercise 13-3 ACTIVITY-BASED CUSTOMER COSTING

OBJECTIVE 2

CORNERSTONE 13-3

Tranax Company sells machine parts to industrial equipment manufacturers by bidding cost plus 40 percent, where cost is defined as manufacturing cost plus order processing cost. There are two types of customers: those who place small, frequent orders and those who place larger, less frequent orders. Cost and sales information by customer category is provided below.

	Frequently Ordering Customers	Less Frequently Ordering Customers
Sales orders	25,000	2,500
Order size	10	100
Average unit manufacturing cost	$40	$40
Order-processing activity costs:		
Processing sales orders		$2,500,000

Order-filling capacity is purchased in steps (order-processing clerks) of 1,000, each step costing $50,000; variable order-filling activity costs are $40 per order. The activity capacity is 28,000 orders; thus, the total order-filling cost is $2,500,000 [(28 steps × $50,000) + ($40 × 27,500)]. Current practice allocates ordering cost in proportion to the units purchased.

Tranax recently lost a bid for 100 units. (The per-unit bid price was $2 per unit more than the winning bid.) The manager of Tranax was worried that this was a recurring trend for the larger orders. (Other large orders had been lost with similar margins of loss.) No such problem was taking place for the smaller orders; the company rarely lost bids on smaller orders.

Required:

1. Calculate the unit bid price offered to Tranax's customers assuming that order-filling cost is allocated to each customer category in proportion to units sold.
2. Assume that a newly implemented ABC system concludes that the number of orders placed is the best cost driver for the order-filling activity. Assign order-filling costs using this driver to each customer type and then calculate the new unit bid price for each customer type. Using this new price, would Tranax have won the bid for the 100 units recently lost?
3. ***What if*** Tranax offers a discount for orders of 25 units or more to the frequently ordering customers? Assume that all the frequently ordering customers can and do take advantage of this offer at the minimum level possible. Can Tranax offer the original price from Requirement 1 to the frequently ordering customers without decreasing its profitability?

OBJECTIVE 3

CORNERSTONE 13-4

Cornerstone Exercise 13-4 ACTIVITY-BASED LIFE-CYCLE COSTING

Charest design engineers are in the process of developing a new "green" product, one that will significantly reduce impact on the environment and yet still provide the desired customer functionality. Currently, two designs are being considered. The manager of Charest has told the engineers that the cost for the new product cannot exceed $550 per unit (target cost). In the past, the Cost Accounting Department has given estimated costs using a unit-based system. At the request of the Engineering Department, Cost Accounting is providing both unit- and activity-based accounting information (made possible by a recent pilot study producing the activity-based data).

Unit-based system:

Variable conversion activity rate: $100 per direct labour hour
Material usage rate: $20 per part

ABC system:

Labour usage: $15 per direct labour hour
Material usage (direct materials): $20 per part
Machining: $75 per machine hour
Purchasing activity: $150 per purchase order
Setup activity: $3,000 per setup hour
Warranty activity: $500 per returned unit (usually requires extensive rework)
Customer repair cost: $25 per repair hour (average)

Activity and Resource Information (annual estimates)

	Design A	Design B
Units produced	25,000	25,000
Direct material usage	300,000 parts	275,000 parts
Labour usage	50,000 hours	120,000 hours
Machine hours	50,000	60,000
Purchase orders	2,000	1,500
Setup hours	600	200
Returned units	1,000	250
Repair time (customer)	2,000	500

Required:

1. Select the lower-cost design using unit-based costing. Are logistical and post-purchase activities considered in this analysis?
2. Select the lower-cost design using ABC analysis. Explain why the analysis differs from the unit-based analysis.
3. ***What if*** the post-purchase cost were an environmental contaminant and amounted to $10 *per unit* for Design A and $40 per unit for Design B? Assume that the environmental cost is borne by society. Now which is the better design?

OBJECTIVE 5

CORNERSTONE 13-5

Cornerstone Exercise 13-5 BACKFLUSH COSTING

Hashen Company has implemented a JIT system and is considering the use of backflush costing. Hashen had the following transactions for the current fiscal year:

1. Purchased raw materials on account for $600,000.
2. Placed all materials received into production.
3. Incurred actual direct labour costs of $90,000.
4. Incurred actual overhead costs of $625,000.
5. Applied conversion costs of $675,000.
6. Completed all work for the month.
7. Sold all completed work.
8. Computed the difference between actual and applied costs.

Required:

1. Prepare the journal entries for traditional and backflush costing. For backflush costing, assume there are two trigger points: (1) the purchase of raw materials and (2) the completion of the goods.

2. Assume the second trigger point in Requirement 1 is the sale of goods. What would change for the backflush costing journal entries?
3. ***What if*** there is only one trigger point and it is (a) completion of the goods or (b) sale of goods? How would the backflush costing journal entries differ from Requirement 1 for (a) and (b)?

Exercises

Exercise 13-6 COMPETITIVE ADVANTAGE: BASIC CONCEPTS

OBJECTIVE 1

SERVICE

Jason Lemieux has decided to purchase a personal computer. He has narrowed his choices to two: Brand A and Brand B. Both brands have the same processing speed, hard disk capacity, CD-ROM drives, and basic software support package. Both come from companies with good reputations. The selling price for each is identical. After some review, Jason discovers that the cost of operating and maintaining Brand A over a three-year period is estimated to be $200. For Brand B, the operating and maintenance cost is $600. The sales agent for Brand A emphasized the lower operating and maintenance cost. She claimed that it was lower than for any other PC brand. The sales agent for Brand B, however, emphasized the service reputation of the product. He provided Jason with a copy of an article appearing in a PC magazine that rated service performance of various PC brands. Brand B was rated number one. Based on all the information, Jason decided to buy Brand B.

Required:

1. What is the total product purchased by Jason?
2. Is the Brand A company pursuing a cost leadership or a differentiation strategy? The Brand B company? Explain.
3. When asked why he purchased Brand B, Jason replied, "I think Brand B offered more value than Brand A." What are the possible sources of this greater value? If Jason's reaction represents the majority opinion, what suggestions could you offer to help improve the strategic position of Brand A?

Exercise 13-7 STRATEGIC POSITIONING

OBJECTIVE 1

SERVICE

Kanata Goodwill Bank has been experiencing significant competition from nonbanking financial service providers such as mutual funds. As a result, interest rates are lower, and the bank is finding it more difficult to maintain or increase deposits. Profits have declined for the past two years. Concerned about the situation, the bank's executive managers have commissioned a consulting group to assess the profitability of the bank's products and customers. The consulting group has implemented an ABC system that traces costs to both products and customers. An ABC customer profitability analysis rates the customers on a scale of one to five, with one being the most lucrative. Customers in the number one category earn an average profit of $1,500 per year for the bank, while customers in the fifth category are costing the bank an average of $500 per year. The consulting group has also conducted a marketing survey and discovered that the higher-end customers are leaving for banks that offer a broader range of financial products. Armed with the financial and marketing information provided by the consulting group, the banking executives have decided to implement the following:

1. Broaden the markets to include investment and insurance products. The goal was to become a complete financial services provider to stop the loss of the higher-end customers. The broadening would also reduce the dependence of the bank on interest-based revenue. (Investment and insurance products produce fee-based revenues.)
2. Alter the customer mix by targeting only the upper three customer segments.
3. Set the bank apart from competitors by offering special, high-quality services to targeted customers:
   a. The upper segment of customers will be classified as "Premier One" and will be issued a gold card. When presenting the card to a concierge at the door, the

customer will be taken to a special teller window with no line, or to the desk of a specially trained bank officer.
   b. For the highest-end customers, no-questions-asked refunds on fees that they think they shouldn't pay (categories one and two). Middle-end customers can negotiate. Low-end customers must pay the fees (categories four and five).
   c. Provide secret, toll-free "VIP" numbers to customers in the Premier One category. In this way, they will have immediate access to a bank official for any inquiry they may have.
   d. Impose a $4 teller fee for lower-end customers (categories four and five).
4. Improve operating efficiency by increasing productivity and eliminating costs that produce no revenues.

Required:

1. Describe the strategic positioning of Kanata Goodwill Bank in terms of the three general strategies: cost leadership, differentiation, and focusing. Of the three, which one(s) are apparently receiving the most emphasis?
2. Describe the role of cost management in defining the strategic position of the bank. What role do you think cost management will play as the bank attempts to establish and enhance its strategic position?

OBJECTIVE 1

Exercise 13-8 DRIVER CLASSIFICATION

Classify the following cost drivers as structural, executional, or operational.

a. Number of plants
b. Number of moves
c. Degree of employee involvement
d. Capacity utilization
e. Number of product lines
f. Number of distribution channels
g. Engineering hours
h. Direct labour hours
i. Scope
j. Product configuration
k. Quality management approach
l. Number of receiving orders
m. Number of defective units
n. Employee experience
o. Types of process technologies
p. Number of purchase orders
q. Type and efficiency of layout
r. Scale
s. Number of functional departments
t. Number of planning meetings

OBJECTIVE 1

Exercise 13-9 OPERATIONAL AND ORGANIZATIONAL ACTIVITIES

Malabar Company has decided to pursue a cost leadership strategy. This decision is prompted, in part, by increased competition from foreign firms. Malabar's management is confident that costs can be reduced by more efficient management of the firm's operational activities. Improving operational activity efficiency, however, often requires some strategic changes in organizational activities. Malabar currently uses a very traditional manufacturing approach. Plants are organized along departmental lines. Management follows a typical pyramid structure. Labour is specialized and located in departments. Quality management follows a conventional acceptable quality level approach. (Batches of products are accepted if the number of defective units is below some predetermined level.) Materials are purchased from a large number of suppliers, and sizable inventories of materials, work in process, and finished goods are maintained. The company produces many different products that use a variety of different parts, many of which are purchased from suppliers.

Required:

Given this brief description of the firm and its setting, for each of the following operational activities and their associated drivers, suggest some strategic changes in organizational activities (and drivers) that might reduce the cost of performing the indicated operational activity. Explain your reasoning.

Operational Activity	Operational Cost Driver
Inspecting products	Number of inspection hours
Moving materials	Distance moved
Reworking products	Number of defective units
Setting up equipment	Setup time
Purchasing parts	Number of different parts
Storing goods and materials	Days in inventory
Expediting orders	Number of late orders
Warranty work	Number of bad units sold

Exercise 13-10 EXTERNAL LINKAGES, ACTIVITY-BASED SUPPLIER COSTING

OBJECTIVE ➤ 2

Meldrum Company manufactures medical equipment. Meldrum produces all the components necessary for the production of one of its products except for one. This component is purchased from two local suppliers: Wood Machining and Gardner Inc. Wood sells the component for $192 per unit, while Gardner sells the same component for $172. Because of the lower price, Meldrum purchases 80 percent of its components from Gardner. Meldrum purchases the remaining 20 percent from Wood to ensure an alternative source. The total annual demand is 1,500,000 components.

Wood's sales manager is pushing Meldrum to purchase more of its units, arguing that its component is of much higher quality and so should prove to be less costly than Gardner's lower-quality component. Wood has sufficient capacity to supply all the components needed and is asking for a long-term contract. With a five-year contract for 1,200,000 or more units, Wood will sell the component for $180 per unit with a contractual provision for an annual product-specific inflationary adjustment. Meldrum's purchasing manager is intrigued by the offer and wonders if the higher-quality component actually does cost less than the lower-quality Gardner component. To help assess the cost effect of the two components, the following data have been collected for quality-related activities and suppliers:

I. Activity data:

Activity	Cost
Inspecting components (sampling only)	$ 1,800,000
Expediting work (due to late delivery)	1,440,000
Reworking products (due to failed component)	10,266,750
Warranty work (due to failed component)	32,400,000

II. Supplier data:

	Wood	Gardner
Unit purchase price	$192	$172
Units purchased	300,000	1,200,000
Expediting orders	15	135
Sampling hours*	30	1,470
Rework hours	135	2,115
Warranty hours	300	5,700

*The Quality Control Department indicates that sampling inspection for the Wood component has been reduced because the reject rate is so low.

Required:

1. Calculate the cost per component for each supplier, taking into consideration the costs of the quality-related activities and using the current prices and sales volume. Given this information, what do you think the purchasing manager ought to do? Explain.

2. Suppose the Quality Control Department estimates that the company loses $6,750,000 in sales per year because of the reputation effect of defective units attributable to failed components. What information would you like to have to assign this cost to each supplier? Suppose that you had to assign the cost of lost sales to each supplier using one of the drivers already listed. Which would you choose? Using this driver, calculate the change in the cost of the Gardner component attributable to lost sales.

OBJECTIVE 2

Exercise 13-11 EXTERNAL LINKAGES, CUSTOMER COSTING, CUSTOMER PROFITABILITY

Carbon Company sells electrical components to medical equipment manufacturers for an average price of $1.05 per part. There are two types of customers: those who place small, frequent orders and those who place larger, less frequent orders. Each time an order is placed and processed, a setup is required. Scheduling is also needed to coordinate the many different orders that come in and place demands on the plant's manufacturing resources. Carbon also inspects a sample of the products each time a batch is produced to ensure that the customer's specifications have been met. Inspection takes essentially the same time regardless of the type of part being produced. Carbon's Cost Accounting Department has provided the following budgeted data for customer-related activities and costs (the amounts expected for the coming year):

	Frequently Ordering Customers	Less Frequently Ordering Customers
Sales orders	14,000	1,400
Average order size	1,400	14,000
Number of setups	17,500	3,500
Scheduling hours	24,500	3,500
Inspections	17,500	3,500
Average unit cost*	$0.56	$0.56

*This cost does not include the cost of the following "customer-related" activities:

Customer-related activity costs:	
Processing sales orders	$1,540,000
Scheduling production	840,000
Setting up equipment	2,520,000
Inspecting batches	3,360,000
Total	$8,260,000

Required:

1. Assign the customer-related activity costs to each category of customers in proportion to the sales revenue earned by each customer type. Calculate the profitability of each customer type. Discuss the problems with this measure of customer profitability.
2. Assign the customer-related activity costs to each customer type using activity rates. Now calculate the profitability of each customer category. As a manager, how would you use this information?

OBJECTIVE 3

Exercise 13-12 PRODUCT LIFE CYCLE

The following statements or phrases are associated with product life-cycle viewpoints. Identify whether each one is associated with the marketing, production, or customer viewpoint. Where possible, identify the particular characteristic being described. If the statement or phrase fits more than one viewpoint, label it as interactive. Explain the interaction.

a. Sales are increasing at an increasing rate.
b. The cost of maintaining the product after it is purchased.
c. The product is losing market acceptance and sales are beginning to decrease.
d. A design is chosen to minimize post-purchase costs.

e. Ninety percent or more of the costs are committed during the development stage.
f. The length of time that the product serves the needs of a customer.
g. All the costs associated with a product for its entire life cycle.
h. The time in which a product generates revenue for a company.
i. Profits tend to reach peak levels during this stage.
j. Customers have the lowest price sensitivity during this stage.
k. Describes the general sales pattern of a product as it passes through distinct life-cycle stages.
l. The concern is with product performance and price.
m. Actions taken so that life-cycle profits are maximized.
n. Emphasizes internal activities that are needed to develop, produce, market, and service products.

Exercise 13-13 JIT AND TRACEABILITY OF COSTS

OBJECTIVE 5

Assume that a company has recently switched to JIT manufacturing. Each manufacturing cell produces a single product or major subassembly. Cell workers have been trained to perform a variety of tasks. Additionally, many services have been decentralized. Costs are assigned to products using direct tracing, driver tracing, and allocation. For each cost listed, indicate the most likely product cost assignment method used *before* JIT and *after* JIT. Set up a table with three columns: Cost Item, Before JIT, and After JIT. You may assume that direct tracing is used whenever possible, followed by driver tracing, with allocation being the method of last resort.

a. Inspection costs
b. Power to heat, light, and cool plant
c. Minor repairs on production equipment
d. Salary of production supervisor (department/cell)
e. Oil to lubricate machinery
f. Salary of plant supervisor
g. Costs to set up machinery
h. Salaries of janitors
i. Power to operate production equipment
j. Taxes on plant and equipment
k. Depreciation on production equipment
l. Raw materials
m. Salary of industrial engineer
n. Parts for machinery
o. Pencils and paper clips for production supervisor (department/cell)
p. Insurance on plant and equipment
q. Overtime wages for cell workers
r. Plant depreciation
s. Materials handling
t. Preventive maintenance

Exercise 13-14 JIT FEATURES AND PRODUCT COSTING ACCURACY

OBJECTIVE 4 5

Prior to installing a JIT system, Beijing Company, a producer of bicycle parts, used maintenance hours to assign maintenance costs to its three products (wheels, seats, and handle bars). The maintenance costs totalled $1,960,000 per year. The maintenance hours used by each product and the quantity of each product produced are as follows:

	Maintenance Hours	Quantity Produced
Wheels	60,000	52,500
Seats	60,000	52,500
Handle bars	80,000	70,000

After installing JIT, three manufacturing cells were created, and cell workers were trained to perform preventive maintenance and minor repairs. A full-time maintenance person was also assigned to each cell. Maintenance costs for the three cells still total $1,960,000; however, these costs are now traceable to each cell as follows:

Cell, wheels	$532,000
Cell, seats	588,000
Cell, handle bars	840,000

Required:

1. Compute the pre-JIT maintenance cost per unit for each product.
2. Compute the maintenance cost per unit for each product after installing JIT.
3. Explain why the JIT maintenance cost per unit is more accurate than the pre-JIT cost.

OBJECTIVE 5

Exercise 13-15 BACKFLUSH COSTING VERSUS TRADITIONAL: VARIATION 1

Milman Company has installed a JIT purchasing and manufacturing system and is using backflush accounting for its cost flows. It currently uses a two-trigger approach with the purchase of materials as the first trigger point and the completion of goods as the second trigger point. During the month of June, Milman had the following transactions:

Raw materials purchased	$486,000
Direct labour cost	81,000
Overhead cost	405,000
Conversion cost applied	526,500*

*$81,000 labour plus $445,500 overhead.

There were no beginning or ending inventories. All goods produced were sold with a 60 percent markup. Any variance is closed to Cost of Goods Sold. (Variances are recognized monthly.)

Required:

1. Prepare the journal entries that would have been made using a traditional accounting approach for cost flows.
2. Prepare the journal entries for the month using backflush costing.

OBJECTIVE 5

Exercise 13-16 BACKFLUSH COSTING: VARIATION 2

Refer to **Exercise 13-15**.

Required:

Prepare the journal entries for the month of June using backflush costing, assuming that Milman uses the sale of goods as the second trigger point instead of the completion of goods.

OBJECTIVE 5

Exercise 13-17 BACKFLUSH COSTING VERSUS TRADITIONAL: VARIATIONS 3 AND 4

Refer to **Exercise 13-15**.

Required:

1. Prepare the journal entries for the month of June using backflush costing, assuming that Milman uses the completion of goods as the only trigger point.
2. Prepare the journal entries for the month of June using backflush costing, assuming that Milman uses the sale of goods as the only trigger point.

OBJECTIVE 4 5

Exercise 13-18 COST ASSIGNMENT AND JIT

Bellagio Company produces two types of glucose monitors (basic and advanced). Both pass through two producing departments: Fabrication and Assembly. Bellagio also has an Inspection Department that is responsible for testing monitors to ensure that they perform within prespecified tolerance ranges (a sampling procedure is used). Budgeted data for the three departments are as follows:

	Inspection	Fabrication	Assembly
Overhead	$480,000	$720,000	$204,000
Number of tests	—	30,000	90,000
Direct labour hours	—	72,000	36,000

In the Fabrication Department, the basic model requires 0.5 hour of direct labour and the advanced model, 1.0 hour. In the Assembly Department, the basic model requires 0.7 hour of direct labour and the advanced model 1.25 hours. There are 45,000 basic units produced and 24,000 advanced units.

Immediately after preparing the budgeted data, a consultant suggests that two manufacturing cells be created: one for the manufacture of the basic model and the other for the manufacture of the advanced model. Raw materials would be delivered to each cell, and goods would be shipped immediately to customers upon completion. Workers within each cell would also be trained to perform monitor testing. The total direct overhead costs estimated for each cell would be $228,000 for the basic cell and $720,000 for the advanced cell.

Required:

1. Allocate the inspection costs to each department, and compute the overhead cost per unit for each monitor. (Overhead rates use direct labour hours.)
2. Compute the overhead cost per unit if manufacturing cells are created. Which unit overhead cost do you think is more accurate—the one computed with a departmental structure, or the one computed using a cell structure? Explain.
3. Note that the total overhead costs for the cell structure are lower. Explain why.

Problems

Problem 13-19 INTERNAL LINKAGES, COST MANAGEMENT, AND STRATEGIC DECISION MAKING

OBJECTIVE 2

Evans Inc. has a unit-based costing system. Evans's Waterloo plant produces 10 different electronic products. The demand for each product is about the same. Although they differ in complexity, each product uses about the same labour time and materials.

The plant has used direct labour hours for years to assign overhead to products. To help design engineers understand the assumed cost relationships, the Cost Accounting Department developed the following cost equation. (The equation describes the relationship between total manufacturing costs and direct labour hours; the equation is supported by a coefficient of determination of 60 percent.)

$$Y = \$5{,}000{,}000 + \$30X, \text{ where } X = \text{direct labour hours}$$

The variable rate of $30 is broken down as follows:

Direct labour	$ 9
Variable overhead	5
Direct materials	16

Because of competitive pressures, product engineering was given the charge to redesign products to reduce the total cost of manufacturing. Using the above cost relationships, product engineering adopted the strategy of redesigning to reduce direct labour content. As each design was completed, an engineering change order was cut, triggering a series of events such as design approval, vendor selection, bill of materials update, redrawing of schematic, test runs, changes in setup procedures, development of new inspection procedures, and so on.

After one year of design changes, the normal volume of direct labour was reduced from 250,000 hours to 200,000 hours, with the same number of products being produced. Although each product differs in its labour content, the redesign efforts reduced the labour content for all products. On average, the labour content per unit of product dropped from 1.25 hours per unit to one hour per unit. Fixed overhead, however, increased from $5,000,000 to $6,600,000 per year.

Suppose that a consultant was hired to explain the increase in fixed overhead costs. The consultant's study revealed that the $30 per hour rate captured the unit-level variable costs; however, the cost behaviour of other activities was quite different. For example, setting up equipment is a step-fixed cost, where each step is 2,000 setup hours, costing $90,000. The study also revealed that the cost of receiving goods is a function of

the number of different components. This activity has a variable cost of $2,000 per component type and a fixed cost that follows a step-cost pattern. The step is defined by 20 components with a cost of $50,000 per step. Assume also that the consultant indicated that the design adopted by the engineers increased the demand for setups from 20,000 setup hours to 40,000 setup hours and the number of different components from 100 to 250. The demand for other non-unit-level activities remained unchanged. The consultant also recommended that management take a look at a rejected design for its products. This rejected design increased direct labour content from 250,000 hours to 260,000 hours, decreased the demand for setups from 20,000 hours to 10,000 hours, and decreased the demand for purchasing from 100 component types to 75 component types, while the demand for all other activities remained unchanged.

Required:

1. Using normal volume, compute the manufacturing cost per labour hour before the year of design changes. What is the cost per unit of an "average" product?
2. Using normal volume after the one year of design changes, compute the manufacturing cost per hour. What is the cost per unit of an "average" product?
3. Before considering the consultant's study, what do you think is the most likely explanation for the failure of the design changes to reduce manufacturing costs? Now use the information from the consultant's study to explain the increase in the average cost per unit of product. What changes would you suggest to improve Evans's efforts to reduce costs?
4. Explain why the consultant recommended a second look at a rejected design. Provide computational support. What does this tell you about the strategic importance of cost management?

OBJECTIVE 2

Problem 13-20 EXTERNAL LINKAGES, ACTIVITY-BASED SUPPLIER COSTING

Campbell Inc. manufactures riding lawn mowers. Campbell uses JIT manufacturing and carries insignificant levels of inventory. Campbell manufactures everything needed for the riding lawn mowers except for the engines. Several sizes of mowers are produced. The most popular line is the small mower line. The engines for the small mower line are purchased from two sources: Rivera Engines and Bach Machining. The Rivera engine is the more expensive of the two sources and has a price of $300. The Bach engine is $270 per unit. Campbell produces and sells 13,200 units of the small mower. Of the 13,200 engines purchased, 2,400 are purchased from Rivera Engines, and 10,800 are purchased from Bach Machining. Although Bill Jackson, production manager, prefers the Rivera engine, Carlos Lopez, purchasing manager, maintains that the price difference is too great to buy more than the 2,400 units currently purchased. Carlos, however, does want to maintain a significant connection with Rivera just in case the less expensive source cannot supply the needed quantities. Even though Bill understands the price argument, he has argued in many meetings that the quality of the Rivera engine is worth the price difference. Carlos remains unconvinced.

Sam Miller, controller, has recently overseen the implementation of an activity-based costing system. He has indicated that an ABC analysis would shed some light on the conflict between production and purchasing. To support this position, the following data have been collected:

I. Activity cost data:

Testing engines[a]	$240,000
Reworking products[b]	400,000
Expediting orders[c]	300,000
Repairing engines[d]	540,000

[a]All units are tested after assembly, and a certain percentage are rejected because of engine failure.
[b]Defective engines are removed, replaced (supplier will replace any failed engine), and retested before being sold to customers. Engine failure often causes collateral damage, and other parts need to be remanufactured and replaced before the unit is again functional.
[c]Due to late or failed delivery of engines.
[d]Repair work is for units under warranty and almost invariably is due to engine failure. Repair usually means replacing the engine. This cost plus labour, transportation, and other costs make warranty work very expensive.

II. Supplier data:

	Bach	Rivera
Engines replaced by source	990	10
Rework hours	4,900	100
Late or failed shipments	99	1
Warranty repairs (by source)	1,220	30

Upon hearing of the proposed ABC analysis, Bill and Carlos were both supportive. Carlos, however, noted that even if the analysis revealed that the Rivera engine was actually less expensive, it would be unwise to completely abandon Bach. He argued that Rivera may be hard pressed to meet the entire demand. Its productive capacity was not sufficient to handle the kind of increased demand that would be imposed. Additionally, having only one supplier was simply too risky.

Required:

1. Calculate the total supplier cost (acquisition cost plus supplier-related activity costs). Convert this to a per-engine cost to find out how much the company is paying for the engines. Which of the two suppliers is the low-cost supplier? Explain why this is a better measure of engine cost than the usual purchase costs assigned to the engines.
2. Consider the supplier cost information obtained in Requirement 1. Suppose further that Rivera can supply only a total of 6,000 units. What actions would you advise Campbell to undertake with its suppliers? Comment on the strategic value of activity-based supplier costing.

Problem 13-21 EXTERNAL LINKAGES, ACTIVITY-BASED CUSTOMER COSTING, AND STRATEGIC DECISION MAKING

OBJECTIVE 2

Moses Manufacturing produces several types of bolts. The products are produced in batches according to customer order. Although there are a variety of bolts, they can be grouped into three product families. The number of units sold is the same for each family. The selling prices for the three families range from $0.50 to $0.80 per unit. Because the product families are used in different kinds of products, customers also can be grouped into three categories, corresponding to the product family they purchase. Historically, the costs of order entry, processing, and handling were expensed and not traced to individual products. These costs are not trivial and totalled $6,300,000 for the most recent year. Furthermore, these costs had been increasing over time. Recently, the company had begun to emphasize a cost reduction strategy; however, any cost reduction decisions had to contribute to the creation of a competitive advantage.

Because of the magnitude and growth of order-filling costs, management decided to explore the causes of these costs. They discovered that order-filling costs were driven by the number of customer orders processed. Further investigation revealed the following cost behaviour:

Step-fixed cost component: $70,000 per step; 2,000 orders define a step*
Variable cost component: $28 per order

*Moses currently has sufficient steps to process 100,000 orders.

The expected customer orders for the year total 140,000. The expected usage of the order-filling activity and the average size of an order by product family are as follows:

	Family A	Family B	Family C
Number of orders	70,000	42,000	28,000
Average order size	600	1,000	1,500

As a result of the cost behaviour analysis, the marketing manager recommended the imposition of a charge per customer order. The president of the company concurred. The charge was implemented by adding the cost per order to the price of each order (computed using the projected ordering costs and expected orders). This ordering cost was then reduced as the size of the order increased and eliminated as the order size reached 2,000 units. (The marketing manager indicated that any penalties imposed for orders greater than this size would lose sales from some of the smaller customers.)

Within a short period of communicating this new price information to customers, the average order size for all three product families increased to 2,000 units.

Required:

1. Moses traditionally has expensed order-filling costs (following GAAP guidelines). Under this approach, how much cost is assigned to customers? Do you agree with this practice? Explain.
2. Consider the following claim: By expensing the order-filling costs, all products were undercosted; furthermore, products ordered in small batches are significantly undercosted. Explain, with supporting computations where possible. Explain how this analysis also reveals the costs of various customer categories.
3. Calculate the reduction in order-filling costs produced by the change in pricing strategy. (Assume that resource spending is reduced as much as possible and that the total units sold remain unchanged.) Explain how exploiting customer linkages produced this cost reduction. Moses also noticed that other activity costs, such as those for setups, scheduling, and materials handling costs, were reduced significantly as a result of this new policy. Explain this outcome, and discuss its implications.
4. Suppose that one of the customers complains about the new pricing policy. This buyer is a lean, JIT firm that relies on small, frequent orders. In fact, this customer accounts for 30 percent of the Family A orders. How should Moses deal with this customer?
5. One of Moses' goals is to reduce costs so that a competitive advantage might be created. Describe how the management of Moses might use this outcome to help create a competitive advantage.

OBJECTIVE ➤ 2

Problem 13-22 INTERNAL AND EXTERNAL LINKAGES, STRATEGIC COST MANAGEMENT

Maxwell Company produces a variety of kitchen appliances, including cooking ranges and dishwashers. Over the past several years, competition has intensified. In order to maintain—and perhaps increase—its market share, Maxwell's management decided that the overall quality of its products had to be increased. Furthermore, costs needed to be reduced so that the selling prices of its products could be reduced. After some investigation, Maxwell concluded that many of its problems could be traced to the unreliability of the parts that were purchased from outside suppliers. Many of these components failed to work as intended, causing performance problems. Over the years, the company had increased its inspection activity of the final products. If a problem could be detected internally, then it was usually possible to rework the appliance so that the desired performance was achieved. Management also had increased its warranty coverage; warranty work had been increasing over the years.

David Haight, president of Maxwell Company, called a meeting with his executive committee. Lee Linsenmeyer, chief engineer, Kit Applegate, controller, and Jeannie Mauro, purchasing manager, were all in attendance. How to improve the company's competitive position was the meeting's topic. The conversation of the meeting was recorded as follows:

DAVID: We need to find a way to improve the quality of our products and at the same time reduce costs. Lee, you said that you have done some research in this area. Would you share your findings?

LEE: As you know, a major source of our quality problems relates to the poor quality of the parts we acquire from the outside. We have a lot of different parts, and this adds to the complexity of the problem. What I thought would be helpful would be to redesign our products so that they can use as many interchangeable parts as possible. This will cut down the number of different parts, make it easier to inspect, and cheaper to repair when it comes to warranty work. My engineering staff has already come up with some new designs that will do this for us.

JEANNIE: I like this idea. It will simplify the purchasing activity significantly. With fewer parts, I can envision some significant savings for my area. Lee has shown me the designs so I know exactly what parts would be needed. I also have a suggestion. We need to embark on a supplier evaluation program. We have too many suppliers. By reducing the number of different parts, we will need fewer suppliers. And we really don't need to

use all the suppliers that produce the parts demanded by the new designs. We should pick suppliers that will work with us and provide the quality of parts that we need. I have done some preliminary research and have identified five suppliers that seem willing to work with us and assure us of the quality we need. Lee may need to send some of his engineers into their plants to make sure that they can do what they are claiming.

DAVID: This sounds promising. Kit, can you look over the proposals and their estimates and give us some idea if this approach will save us any money? And if so, how much can we expect to save?

KIT: Actually, I am ahead of the game here. Lee and Jeannie have both been in contact with me and have provided me with some estimates on how these actions would affect different activities. I have prepared a handout that includes an activity table revealing what I think are the key activities affected. I have also assembled some tentative information about activity costs. The table gives the current demand and the expected demand after the changes are implemented. With this information, we should be able to assess the expected cost savings.

Handout

Activities	Activity Driver	Capacity	Current Demand	Expected Demand
Purchasing parts	Number of different parts	2,000	2,000	500
Inspecting products	Inspection hours	50,000	50,000	25,000
Reworking products	Number reworked	As needed	62,500	25,000
Warranty repair	Number of defective products	10,000	9,000	3,500

Additionally, the following activity cost data are provided:

Purchasing parts: Variable activity cost: $30 per part number; 20 salaried clerks, each earning a $45,000 annual salary. Each clerk is capable of processing orders associated with 100 part numbers.

Inspecting parts: Twenty-five inspectors, each earning a salary of $40,000 per year. Each inspector is capable of 2,000 hours of inspection.

Reworking products: Variable activity cost: $25 per unit reworked (labour and parts).

Warranty: Twenty repair agents, each paid a salary of $35,000 per year. Each repair agent is capable of repairing 500 units per year. Variable activity costs: $15 per product repaired.

Required:

1. Compute the total savings possible as reflected by Kit's handout. Assume that resource spending is reduced where possible.
2. Explain how redesign and supplier evaluation are linked to the savings computed in Requirement 1. Discuss the importance of recognizing and exploiting internal and external linkages.
3. Identify the organizational and operational activities involved in the strategy being considered by Maxwell Company. What is the relationship between organizational and operational activities?

Problem 13-23 EXTERNAL LINKAGES AND STRATEGIC COST MANAGEMENT

OBJECTIVE ➤ 1 2

Cree Works makes machine parts for manufacturers of industrial equipment. Over the years, Cree has been a steady and reliable supplier of quality parts to medium and small machine manufacturers. Michael Murray, owner of Cree Works, once again is disappointed in the year-end income statement. Profits have again failed to meet expectations. The performance is particularly puzzling given that the shop is operating at 100 percent capacity and has been for two years—ever since it landed a *Fortune 500* firm as a regular customer. This firm currently supplies 40 percent of the business—a figure that has grown over the two years. Convinced that something is wrong, Michael calls Brooke Harker, a partner in a large regional CA firm. Brooke has agreed to look into the matter.

A short time later, Brooke makes an appointment to meet with Michael. Their conversation is recorded as follows:

BROOKE: Michael, I think I have pinpointed your problem. I think your main difficulty is poor pricing—you're undercharging your major customer. The firm is getting high-precision machined parts for much less than the cost to you. And I bet that you have been losing some of your smaller customers. You may want to rethink your strategic position. You are a small player in the industrial machine industry. This *Fortune 500* customer has 40 percent of the industrial machine market. Over the years, you have carved out a good reputation among small- and medium-size manufacturers. Right?

MICHAEL: Well, you're right. Over the years, our customers have not been giants. But we saw this business with the *Fortune 500* company as an opportunity to play in the big leagues. We thought it might mean the opportunity to expand the size of our operation. And we have expanded—at least we have added employees and some specialized engineering equipment. My engineering and programming costs have skyrocketed—resource increases we needed, though, to meet the specs of this larger customer. Profits have increased slightly, but nothing like I expected. You're also right about losing some of our smaller customers. Many have complained that the price of their jobs has increased. They have all indicated that they like the work we do and that we are conveniently located, but they argue that they simply cannot afford to keep paying the price we require. The small customers we have kept are also complaining and threatening to go elsewhere. I doubt we'll be able to hold on to their business for much longer—unless a change is made. So far, though, the business we have lost has been replaced with more orders from our large customer. I expect we could do even more business for the large customer. But how can the large buyer be getting the great deal you've described? It has the same markup as our regular jobs—full manufacturing cost plus 25 percent.

BROOKE: I have prepared a report illustrating the total overhead costs for a typical quarter. This report details your major activities and their associated costs. It also provides a comparison of a typical job for your small customers and the typical job for your large customer. Part of the problem is that your accounting system does not react to certain external events. It fails to show the effect of the large customer's activities on your activities and those that relate to your other customers. Given that you assign overhead costs using machine hours, I think you'll find it quite revealing.

MICHAEL: I'll have my controller examine the report for me. You know, if you are right about underpricing the large customer, I have a big problem. I'm not sure that I can increase the price of the parts without losing this big guy's business. After all, it can go to a dozen machine shops like mine and get the work done. A price increase may not work. Then I'd be faced with the loss of 40 percent of my jobs. I suppose, though, that I might be able to regain most of the business with the small customers. In fact, I am positive that we could get most of that business back. I wonder if that's what I ought to do.

Report Regional CA Firm

I. Major Activities and Their Costs

Activity	Total Activity Costs	Cost Behaviour*
Setups	$209,000	Variable
Engineering	151,200	Step-fixed, step = 105 hours
NC programming	130,400	Variable
Machining	100,000	Variable
Rework	101,400	Variable
Inspecting	23,000	Step-fixed, step = 230 hours
Sales support	80,000	Step-fixed, step = 23 orders
Total	$795,000	

*Behaviour is defined with respect to individual cost drivers. The costs given are total costs for the quarter's activities. Thus, for step-fixed costs, the reported activity cost is for all steps being used by the activity; the cost per step is the total cost divided by the number of steps being used.

II. Job Profiles

Resources Used	Small Customer Job	*Fortune 500* Job
Setup hours	3	10
Engineering hours	2	6
Programming hours	1	8
Defective units	20	10
Inspection hours	2	2
Machine hours	2,000	200
Prime costs	$14,000	$1,600
Other data:		
Job size	1,000 parts	100 parts
Quarterly jobs (orders)	15	100
Overhead rate	$14.30 per machine hour	$14.30 per machine hour

Note: All activities are being fully utilized each quarter. (There is no unused activity capacity.)

Required:

1. Without any calculation, explain why the machining company is losing money. Discuss the strategic insights provided by knowledge of activities, their costs, and customer linkages. Comment on the observation made by Brooke that the current accounting system fails to reflect external events. What changes would be needed to correct this deficiency (if true)?
2. Compute the unit price currently being charged each customer type (using machine hours to assign overhead costs).
3. Compute the unit price that would be charged each customer assuming that overhead is assigned using an ABC approach. Was the CA right? Is the large customer paying less than the cost of producing the unit? How is this conclusion affected if the sales support activity is traced to jobs? (Use orders—jobs—as the cost driver.)
4. Compute the quarterly profit that is currently being earned and the amount that would be earned if Cree Works sold only to small customers (a small customer strategy). For the second income statement, use ABC for cost assignments. For the second income statement, the large customer is replaced with 10 smaller customers with the same characteristics as the 15 currently buying parts from Cree. Assume that any opportunities to reduce resource spending and usage will be reflected in the profit associated with a small customer strategy. Also, only the cost of activity usage is assigned to jobs. Any cost of unused activity is reported as a separate item on the income statement. Report sales support as a period expense.
5. What change in strategy would you recommend? In making this recommendation, consider the firm's value-chain framework.

Problem 13-24 LIFE-CYCLE COST MANAGEMENT AND TARGET COSTING

OBJECTIVE 3

Nico Parts Inc. produces electronic products with short life cycles (of less than two years). Development has to be rapid, and the profitability of the products is tied strongly to the ability to find designs that will keep production and logistics costs low. Recently, management has also decided that post-purchase costs are important in design decisions. Last month, a proposal for a new product was presented to management. The total market was projected at 200,000 units (for the two-year period). The proposed selling price was $130 per unit. At this price, market share was expected to be 25 percent. The manufacturing and logistics costs were estimated to be $120 per unit.

Upon reviewing the projected figures, Brian Metcalf, president of Nico, called in his chief design engineer, Mark Williams, and his marketing manager, Cathy Chan. The following conversation was recorded:

BRIAN: Mark, as you know, we agreed that a profit of $15 per unit is needed for this new product. Also, as I look at the projected market share, 25 percent isn't acceptable. Total profits need to be increased. Cathy, what suggestions do you have?

CATHY: Simple. Decrease the selling price to $125 and we expand our market share to 35 percent. To increase total profits, however, we need some cost reductions as well.

BRIAN: You're right. However, keep in mind that I do not want to earn a profit that is less than $15 per unit.

MARK: Does that $15 per unit factor in preproduction costs? You know we have already spent $100,000 on developing this product. To lower costs will require more expenditure on development.

BRIAN: Good point. No, the projected cost of $120 does not include the $100,000 we have already spent. I do want a design that will provide a $15-per-unit profit, including consideration of preproduction costs.

CATHY: I might mention that post-purchase costs are important as well. The current design will impose about $10 per unit for using, maintaining, and disposing of our product. That's about the same as our competitors. If we can reduce that cost to about $5 per unit by designing a better product, we could probably capture about 50 percent of the market. I have just completed a marketing survey at Mark's request and have found out that the current design has two features not valued by potential customers. These two features have a projected cost of $6 per unit. However, the price consumers are willing to pay for the product is the same with or without the features.

Required:

1. Calculate the target cost associated with the initial 25 percent market share. Does the initial design meet this target? Now calculate the *total* life-cycle profit that the current (initial) design offers (including preproduction costs).
2. Assume that the two features that are apparently not valued by consumers will be eliminated. Also assume that the selling price is lowered to $125.
   a. Calculate the target cost for the $125 price and 35 percent market share.
   b. How much more cost reduction is needed?
   c. What are the total life-cycle profits now projected for the new product?
   d. Describe the three general approaches that Nico can take to reduce the projected cost to this new target. Of the three approaches, which is likely to produce the most reduction?
3. Suppose that the Engineering Department has two new designs: Design A and Design B. Both designs eliminate the two nonvalued features. Both designs also reduce production and logistics costs by an *additional* $8 per unit. Design A, however, leaves post-purchase costs at $10 per unit, while Design B reduces post-purchase costs to $4 per unit. Developing and testing Design A costs an additional $150,000, while Design B costs an additional $300,000. Assuming a price of $125, calculate the total life-cycle profits under each design. Which would you choose? Explain. What if the design you chose cost an additional $500,000 instead of $150,000 or $300,000? Would this have changed your decision?
4. Refer to Requirement 3. For every extra dollar spent on preproduction activities, how much benefit was generated? What does this say about the importance of knowing the linkages between preproduction activities and later activities?

OBJECTIVE ➤ 3

Problem 13-25 LIFE-CYCLE COST MANAGEMENT

Tiffany Ball, manager of Farouk Company, has committed her company to a strategically sound cost reduction program. Emphasizing life-cycle cost management is a major part of this effort. Tiffany is convinced that production costs can be reduced by paying more attention to the relationships between design and manufacturing. Design engineers need to know what causes manufacturing costs. She has instructed her controller to develop a manufacturing cost formula for a newly proposed product. Marketing has already projected sales of 25,000 units for the new product. (The life cycle is estimated to be 18 months. The company expects to have 50 percent of the market and has priced its product to achieve this goal.) The projected selling price is $20 per unit. The following cost formula has been developed:

$$Y = \$200{,}000 + \$10X_1$$

where

X_1 = Machine hours (The product is expected to use one machine hour for every unit produced.)

Upon seeing the cost formula, Tiffany quickly calculates the projected gross profit to be $50,000. This produces a gross profit of $2 per unit, well below the targeted gross profit of $4 per unit. Tiffany then sends a memo to the Engineering Department, instructing them to search for a new design that will lower the costs of production by at least $50,000 so that the target profit can be met.

Within two days, the Engineering Department proposes a new design that will reduce unit-variable cost from $10 per machine hour to $8 per machine hour (Design Z). The chief engineer, upon reviewing the design, questions the validity of the controller's cost formula. He suggests a more careful assessment of the proposed design's effect on activities other than machining. Based on this suggestion, the following revised cost formula has been developed. This cost formula reflects the cost relationships of the most recent design (Design Z).

$$Y = \$140{,}000 + \$8X_1 + \$5{,}000X_2 + \$2{,}000X_3$$

where

X_1 = Units sold
X_2 = Number of batches
X_3 = Number of engineering change orders

Based on scheduling and inventory considerations, the product will be produced in batches of 1,000; thus, 25 batches will be needed over the product's life cycle. Furthermore, based on past experience, the product will likely generate about 20 engineering change orders.

This new insight into the linkage of the product with its underlying activities has led to a different design (Design W). This second design also lowers the unit-level cost by $2 per unit but has decreased the number of design support requirements from 20 orders to 10 orders. Attention is also given to the setup activity, and the design engineer assigned to the product has created a design that reduces setup time and lowers variable setup costs from $5,000 to $3,000 per setup. Furthermore, Design W also creates excess activity capacity for the setup activity, and resource spending for setup activity capacity can be decreased by $40,000, reducing the fixed cost component in the equation by this amount.

Design W is recommended and accepted. As prototypes of the design are tested, an additional benefit has emerged. Based on test results, the post-purchase costs will drop from an estimated $0.70 per unit sold to $0.40 per unit sold. Using this information, the Marketing Department has revised the projected market share upward from 50 percent to 60 percent (with no price decrease).

Required:

1. Calculate the expected gross profit per unit for Design Z using the controller's original cost formula. According to this outcome, does Design Z reach the targeted unit profit? Repeat, using the engineer's revised cost formula. Explain why Design Z failed to meet the targeted profit. What does this say about the use of unit-based costing for life-cycle cost management?
2. Calculate the expected profit per unit using Design W. Comment on the value of activity information for life-cycle cost management.
3. The benefit of the post-purchase cost reduction of Design W was discovered in testing. What direct benefit did it create for Farouk Company (in dollars)? Reducing post-purchase costs was not a specific design objective. Should it have been? Are there any other design objectives that should have been considered?

OBJECTIVE 4 5

Problem 13-26 JIT, TRACEABILITY OF COSTS, PRODUCT COSTING ACCURACY, JIT EFFECTS ON COST ACCOUNTING SYSTEMS

Homer Manufacturing produces different models of 22-calibre rifles. The manufacturing costs assigned to its economy model rifle before and after installing JIT are given in the following table. Cell workers do all maintenance and are also responsible for moving materials, cell janitorial work, and inspecting products. Janitorial work outside the cells is still handled by the Janitorial Department.

In both the pre- and post-JIT setting, 10,000 units of the economy model are manufactured. In the JIT setting, manufacturing cells are used to produce each product. The management of Homer Manufacturing reported a significant decrease in manufacturing costs for all of its rifles after JIT was installed. It also reported less inventory-related costs and a significant decrease in lead times. Accounting costs also decreased because Homer switched from a job-order costing system to a process-costing system.

	Before	After
Direct materials	$ 60,000	$ 55,000
Direct labour	40,000	50,000
Maintenance	50,000	30,000
Inspection	30,000	10,000
Rework	60,000	9,000
Power	10,000	6,000
Depreciation	12,500	10,000
Materials handling	8,000	2,000
Engineering	80,000	50,000*
Setups	15,000	—
Janitorial	40,000	20,000
Building and grounds	11,800	12,400
Supplies	4,000	3,000
Supervision (plant)	10,000	8,000
Cell supervision	—	35,000
Cost accounting	40,000	25,000
Departmental supervision	18,000	—
Total	$489,300	$325,400

*Salary of engineer assigned to the cell.

Required:

1. Compute the unit cost of the product before and after JIT.
2. Explain why the JIT unit cost is more accurate. Also explain what JIT features may have produced a decrease in production costs. Use as many specific cost items as possible to illustrate your explanation.
3. Explain why Homer Manufacturing switched from a job-order costing system to a process-costing system after JIT was implemented.
4. Classify the costs in the JIT environment according to how they are assigned to the cell: direct tracing, driver tracing, or allocation. Which cost assignment method is most common? What does this imply regarding product costing accuracy?

OBJECTIVE 4 5

Problem 13-27 JIT AND PRODUCT COSTING

Mott Company recently implemented a JIT manufacturing system. After one year of operation, Heidi Burrows, president of the company, wanted to compare product cost under the JIT system with product cost under the old system. Mott's two products are weed eaters and lawn edgers. The unit prime costs under the old system are as follows:

	Eaters	Edgers
Direct materials	$12	$45
Direct labour	4	30

Under the old manufacturing system, the company operated three service centres and two production departments. Overhead was applied using departmental overhead rates.

The direct overhead costs associated with each department for the year preceding the installation of JIT are as follows:

Maintenance	$110,000
Materials handling	90,000
Building and grounds	150,000
Machining	280,000
Assembly	175,000
Total	$805,000

Under the old system, the overhead costs of the service departments were allocated directly to the producing departments and then to the products passing through them. (Both products passed through each producing department.) The overhead rate for the Machining Department was based on machine hours, and the overhead rate for assembly was based on direct labour hours. During the last year of operations for the old system, the Machining Department used 80,000 machine hours, and the Assembly Department used 20,000 direct labour hours. Each weed eater required 1.0 machine hour in Machining and 0.25 direct labour hour in Assembly. Each lawn edger required 2.0 machine hours in Machining and 0.5 hour in Assembly. Bases for allocation of the service costs are as follows:

	Machine Hours	Number of Material Moves	Square Metres of Space
Machining	80,000	90,000	80,000
Assembly	20,000	60,000	40,000
Total	100,000	150,000	120,000

Upon implementing JIT, a manufacturing cell for each product was created to replace the departmental structure. Each cell occupied 10,000 square metres. Maintenance and materials handling were both decentralized to the cell level. Essentially, cell workers were trained to operate the machines in each cell, assemble the components, maintain the machines, and move the partially completed units from one point to the next within the cell. During the first year of the JIT system, the company produced and sold 20,000 weed eaters and 30,000 lawn edgers. This output was identical to that for the last year of operations under the old system. The following costs have been assigned to the manufacturing cells:

	Eater Cell	Edger Cell
Direct materials	$185,000	$1,140,000
Direct labour	66,000	660,000
Direct overhead	99,000	350,500
Allocated overhead*	75,000	75,000
Total	$425,000	$2,225,500

*Building and grounds are allocated on the basis of square metres.

Required:

1. Compute the unit cost for each product under the old manufacturing system.
2. Compute the unit cost for each product under the JIT system.
3. Which of the unit costs is more accurate? Explain. Include in your explanation a discussion of how the computational approaches differ.
4. Calculate the decrease in overhead costs under JIT, and provide some possible reasons that explain the decrease.

Problem 13-28 BACKFLUSH COSTING, CONVERSION RATE

OBJECTIVE 4 5

Gee Company has implemented a JIT flexible manufacturing system. Gary Polson, controller of the company, has decided to reduce the accounting requirements given the expectation of lower inventories. For one thing, he has decided to treat direct labour cost

as a part of overhead and to discontinue the detailed direct labour accounting of the past. The company has created two manufacturing cells, each capable of producing a family of products: the carburetor cell and the battery cell. The output of both cells is sold to a sister division and to customers who use the batteries and carburetors for repair activity. Product-level overhead costs outside the cells are assigned to each cell using appropriate drivers. Facility-level costs are allocated to each cell on the basis of square metres. The budgeted direct labour and overhead costs are as follows:

	Carburetor Cell	Battery Cell
Direct labour costs	$ 90,000	$ 45,000
Direct overhead	360,000	180,000
Product sustaining	135,000	54,000
Facility level	90,000	45,000
Total conversion cost	$675,000	$324,000

The predetermined conversion cost rate is based on available production hours in each cell. The carburetor cell has 22,500 hours available for production, and the battery cell has 13,500 hours. Conversion costs are applied to the units produced by multiplying the conversion rate by the actual time required to produce the units. The carburetor cell produced 40,500 units, taking 0.5 hour to produce one unit of product (on average). The battery cell produced 45,000 units, taking 0.25 hour to produce one unit of product (on average).

Other actual results for the year are as follows:

Direct materials purchased and issued	$765,000
Direct labour costs	135,000
Overhead	945,000

All units produced were sold. Any conversion cost variance is closed to Cost of Goods Sold.

Required:

1. Calculate the predetermined conversion cost rates for each cell.
2. Prepare journal entries using backflush accounting. Assume two trigger points, with completion of goods as the second trigger point.
3. Repeat Requirement 2, assuming that the second trigger point is the sale of the goods.
4. Explain why there is no need to have a work-in-process inventory account.
5. Two variants of backflush costing were presented in which each used two trigger points, with the second trigger point differing. Suppose that the only trigger point for recognizing manufacturing costs occurs when the goods are sold. How would the entries be listed here? When would this backflush variant be considered appropriate?

OBJECTIVE ➤ 4 5

Problem 13-29 JIT, CREATION OF MANUFACTURING CELLS, BEHAVIOURAL CONSIDERATIONS, IMPACT ON COSTING PRACTICES

Reddy Heaters Inc. produces insert heaters that can be used for various applications, ranging from coffeepots to submarines. Because of the wide variety of insert heaters produced, Reddy uses a job-order costing system. Product lines are differentiated by the size of the heater. In the early stages of the company's history, sales were strong and profits steadily increased. In recent years, however, profits have been declining, and the company has been losing market share. Alarmed by the deteriorating financial position of the company, President Doug Young requested a special study to identify the problems. Sheri Butler, the head of the Internal Audit Department, was put in charge of the study. After two months of investigation, Sheri was ready to report her findings.

SHERI: Doug, I think we have some real concerns that need to be addressed. Production is down, employee morale is low, and the number of defective units that we have to scrap is way up. In fact, over the past several years, our scrap rate has increased from 9 percent to 15 percent of total production. And scrap is expensive. We don't detect defective units until the end of the process. By that time, we lose everything. The nature of the product simply doesn't permit rework.

DOUG: I have a feeling that the increased scrap rate is related to the morale problem you've encountered. Do you have any feel for why morale is low?

SHERI: I get the feeling that boredom is a factor. Many employees don't feel challenged by their work. Also, with the decline in performance, they are receiving more pressure from their supervisors, which simply aggravates the problem.

DOUG: What other problems have you detected?

SHERI: Well, much of our market share has been lost to foreign competitors. The time it takes us to process an order, from time of receipt to delivery, has increased from 20 to 30 days. Some of the customers we have lost have switched to Japanese suppliers, from whom they receive heaters in less than 15 days. Added to this delay in our delivery is an increase in the number of complaints about poorly performing heaters. Our quality has definitely taken a nosedive over the past several years.

DOUG: It's amazing that it has taken us this long to spot these problems. It's incredible to me that the Japanese can deliver a part faster than we can, even on our more efficient days. I wonder what their secret is.

SHERI: I investigated that very issue. It appears that they can produce and deliver their heaters rapidly because they use a JIT purchasing and manufacturing system.

DOUG: Can we use this system to increase our competitive ability?

SHERI: I think so, but we'll need to hire a consultant to tell us how to do it. Also, it might be a good idea to try it out on only one of our major product lines. I suggest the small heater line. It is having the most problems and has been showing a loss for the past two years. If JIT can restore this line to a competitive mode, then it'll work for the other lines as well.

Within a week, Reddy Heaters hired the services of a large CA firm. The firm sent Kim Burnham, one of its managers, to do the initial background work. After spending some time at the plant, Kim wrote up the following description of the small heater production process:

> *The various departments are scattered throughout the factory. Labour is specialized and trained to operate the machines in the respective departments. Additionally, the company has a centralized stores area that provides the raw materials for production, a centralized Maintenance Department that has responsibility for maintaining all production equipment, and a group of labourers responsible for moving the partially completed units from department to department.*
>
> *Under the current method of production, small heaters pass through several departments, where each department has a collection of similar machines. The first department cuts a metal pipe into one of three lengths: seven, ten, and twelve centimetres long. The cut pipe is then taken to the Laser Department, where the part number is printed on the pipe. In a second department, ceramic cylinders—cut to smaller lengths than the pipe—are wrapped with a fine wire (using a wrapping machine). The pipe and the wrapped ceramic cylinders are then taken to the Welding Department, where the wrapped ceramic cylinders are placed inside the pipe, centred, and filled with a substance that prevents electricity from reaching the metal pipe. Finally, the ends of the pipe are welded shut with two wire leads protruding from one end. This completed heater is then transferred to the Testing Department, which uses special equipment to see if the heater functions properly.*
>
> *The small heaters are produced in batches of 300. It takes 50 hours to cut 300 metal pipes and prepare 300 ceramic cylinders (1/6 hour per unit, both processes occurring at the same time). After 50 hours of production time, the 300 metal pipes are transported to the Laser Department (20 minutes transport time), and the 300 ceramic cylinders are transported to the Welding Department (20 minutes transport time). In the Laser Department, it takes 50 hours to imprint the part number (1/6 hour per pipe). The 300 metal pipes are then transported to the Welding Department. In the Welding Department, the ceramic and metal pipes are joined and welded. The welding process takes*

50 hours (1/6 hour per pipe). Finally, the 300 units are transported (20 minutes) to the Testing Department. Each unit requires 1/6 hour for testing, or a total of 50 hours for the 300 units. From start to finish, the total production time for the 300 units is as follows:

Cutting and ceramic	*50 hours*
Laser	*50*
Welding	*50*
Testing	*50*
Moving	*1*
Total time	*201 hours*

Notice that Laser must wait 50 hours before it can begin imprinting. Similarly, Welding must wait 100 hours before it can begin working on the batch, and finally, Testing must wait 150 hours before it can begin working on the batch.

Based on the information gathered, Kim estimated that the production time for 300 units could be cut from 201 hours to about 50 hours by creating a small heater manufacturing cell.

Required:

1. One of the first actions taken by Reddy Heaters was to organize a manufacturing cell for the small heater line. Describe how you would organize the manufacturing cell. How does it differ from the traditional arrangement? Will any training costs be associated with the transition to JIT? Explain.
2. Explain, with computational support, how the production time for 300 units can be reduced to about 50 hours. If this is a true reduction in production time, what implications does it have for Reddy's competitive position?
3. Describe the organizational and operational activities that must be managed to bring about the reduction in production time. What are the cost drivers associated with these activities? For operational drivers, indicate the expected effect on activity costs.
4. Initially, the employees resented the change to JIT. After a small period of time, however, morale improved significantly. Explain why the change to JIT increased employee morale.
5. Within a few months, Reddy was able to offer a lower price for its small heaters. Additionally, the number of complaints about the performance of the small heaters declined sharply. By the end of the second year, the product line was reporting profits greater than had ever been achieved. Discuss the JIT features that may have made the lower price and higher profits possible.
6. Within a year of the JIT installation, Reddy's controller remarked, "We have a much better idea than ever before of what it is costing us to produce these small insert heaters." Offer some justification for the controller's statement.
7. Discuss the impact that JIT has on other management accounting practices.

CMA Problem

CMA Problem 13-1 LIFE CYCLE COST MANAGEMENT*

Ariston Manufacturing produces components used in a TV assembly. One of its divisions is currently considering two different designs: one using galvanized steel and the other using polymer. Both designs are considered equally durable. The main issue being considered is the environmental effects of the designs. To help in the assessment, an inventory analysis and associated cost information for the two designs are given below.

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	Polymer	Galvanized Steel
Materials:		
Virgin materials (kilograms)	8	14
Reused production scrap (kilograms)	1	6
Energy:		
During production (kilowatt-hours/kilogram)	15	10
During product use (kilograms of petroleum used per year per unit)	66	110
Containments:		
Gaseous residues (kilograms per unit)	0.4	0.2
Solid residues (kilograms per unit)	0.6	2.0
Recycle potential:		
Incineration (kilograms)	7.0	–
Quantity to landfill (kilograms)	1.0	0.5
Recycled (kilograms)	–	8.5
Financial Information:		
Cost per kilogram of raw materials	$ 30.00	$ 15.00
Cost per kilowatt-hour	0.50	0.50
Cost per kilogram of petroleum	0.70	0.70
Cost per kilogram of gaseous residue	100.00	100.00
Cost per kilogram of solid residue	40.00	50.00
Incineration benefits per unit	2.00	–
Recyclable benefits per unit	–	20.00

Required:

1. Using the operational measures, assess the environmental impact of each design. What other information would be useful?
2. Using the financial information, calculate an environmental life-cycle cost per unit. Discuss the strengths and weaknesses of this information.
3. Explain why a manger might wish to include product use and disposal information in the assessment of the environmental performance. After all, these costs are not incurred by the company. For example, the petroleum consumption per year is a cost incurred by the end users.
4. Based on all the information, what recommendation would you make? *(Adapted from CMA Ontario)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

1. Describe how activity-based management and activity-based costing differ.
2. Define process value analysis.
3. Describe activity-based financial performance measurement.
4. Discuss the implementation issues associated with an activity-based management system.
5. Explain how activity-based management is a form of responsibility accounting, and tell how it differs from financial-based responsibility accounting.

CHAPTER

14 Activity-Based Management

Many firms operate in rapidly changing environments. Typically, these firms face stiff national and international competition. This stringent competitive environment demands that firms offer customized products and services to diverse customer segments. This, in turn, means that firms must find cost-efficient ways of producing high-variety, low-volume products. To find ways to improve performance, firms operating in this kind of environment not only must know what it currently *costs* to do things, but must also evaluate *why* and *how* they do things. Improving performance translates into constantly searching for ways to eliminate waste—a process known as **continuous improvement**. Activity-based costing and activity-based management are important tools in this ongoing improvement effort.

The Relationship of Activity-Based Costing and Activity-Based Management

OBJECTIVE 1
Describe how activity-based management and activity-based costing differ.

Processes are the source of many of the improvement opportunities that exist within an organization. Processes are made up of activities that are linked to perform a specific objective. Improving processes means improving the way activities are performed. Thus, management of activities, not costs, is the key to successful control for firms operating in continuous improvement environments. The realization that activities are crucial to both improved product costing and effective control has led to a new view of business processes called activity-based management.

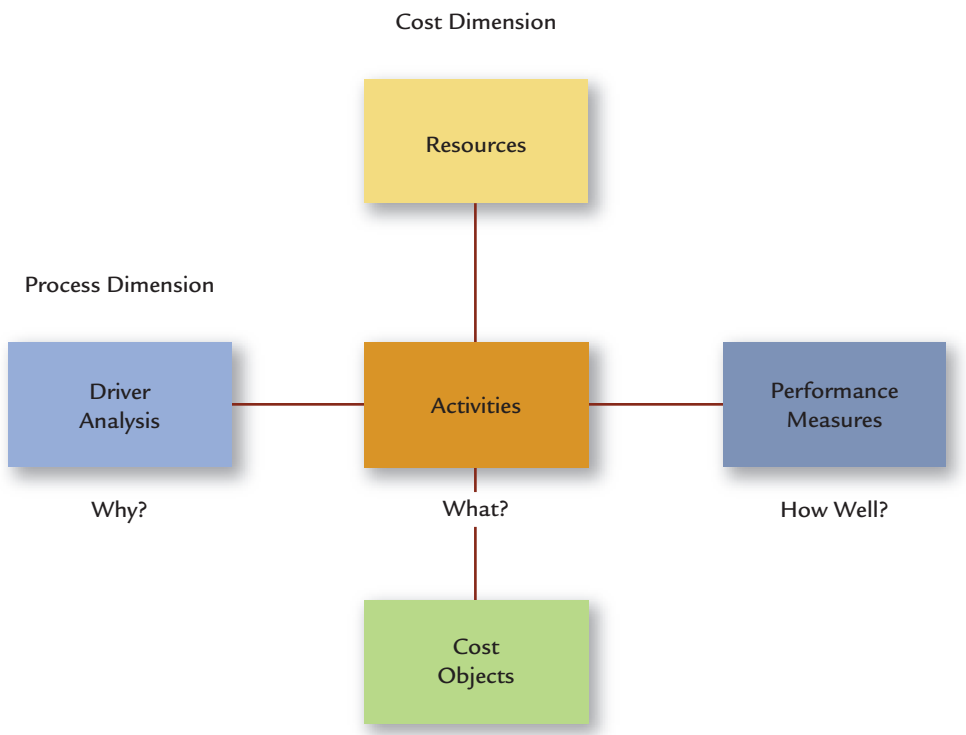
Activity-based management (ABM) is a systemwide, integrated approach that focuses management's attention on activities with the objective of improving customer value as well as the profit achieved by providing this value. ABC is the major source of information for activity-based management. Thus, the activity-based management model has two dimensions: a cost dimension and a process dimension. This two-dimensional model is presented in Exhibit 14-1.

The cost dimension provides cost information about resources, activities, and cost objects of interest such as products, customers, suppliers, and distribution channels. *The objective of the cost dimension is improving the accuracy of cost assignments.* As the model suggests, the cost of resources is traced to activities, and then the cost of activities is assigned to cost objects. This activity-based costing dimension is useful for product costing, strategic cost management, and tactical analysis.

The process dimension provides information about what activities are performed, why they are performed, and how well they are performed. *This dimension's objective is cost reduction*. It is this dimension that provides the ability to engage in and measure continuous improvement. To understand how the process view connects with continuous improvement, a more explicit understanding of process value analysis is needed.

Exhibit 14-1

The Two-Dimensional Activity-Based Management Model



OBJECTIVE 2
Define process value analysis.

Process Dimension: Process Value Analysis

Process value analysis (PVA) is fundamental to activity-based Management. It focuses on accountability for activities rather than costs, and emphasizes the maximization of systemwide performance instead of individual performance. Process value analysis moves activity management from a conceptual basis to an operational basis. As the model in Exhibit 14-1 illustrates, process value analysis is concerned with (1) *driver analysis*, (2) *activity analysis*, and (3) *performance measurement.*

Driver Analysis: Defining Root Causes

Managing activities requires an understanding of what factors cause activities to be performed and what causes activity costs to change. Activities consume inputs (resources) and produce outputs. For example, if the activity is maintaining the payroll master file, the resources used would be such things as a payroll clerk, a computer, a printer, computer paper, and disks. The output would be an updated employee file. An **activity output measure** is the number of times the activity is performed. It is the quantifiable measure of the output. For example, the number of employee files maintained is a possible output measure for maintaining the payroll master file.

The activity output measure calculates the demands placed on an activity and is an *activity driver*. As the demands for an activity change, the cost of the activity can change. For example, as the number of employee files maintained increases, the activity of maintaining the master payroll may need to consume more inputs (labour, disks, paper, and so on). However, output measures (activity drivers), such as the number of files maintained, may not and usually do not correspond to the *root causes* of activity costs; rather, they are the consequences of the activity being performed. The purpose of **driver analysis** is to reveal the root causes of activity costs. For example, an analysis may reveal that the root cause of treating and disposing of toxic waste is product design. Once the root cause is known, action can be taken to improve the activity. Specifically, creating a new product design may reduce or eliminate the cost of treating and disposing of toxic waste.

Often, several activities may have the same root cause. For example, the costs of inspecting incoming components (output measure: number of inspection hours) and reordering (output measure: number of reorders) may both be caused by poor quality of purchased components. By working with carefully selected suppliers to help them improve their product quality, both activities may be improved.

Typically, root causes are identified by asking one or more "why" questions. Example: Why are we inspecting incoming components? Answer: Because some may be defective. Question: Why are we reordering components? Answer: Because some components are judged to be defective by the inspection. Question: Why are some purchased components defective? Answer: Because our suppliers are not providing reliable components. Once the answers to the why questions are obtained, the answers to "how" questions are possible. Example: How do we improve the quality of incoming components? Answer: By selecting (or developing) suppliers that provide higher-quality components. The why questions identify the root causes, and the how questions enable management to identify ways to improve.

Activity Analysis: Identifying and Assessing Value Content

Activity analysis is the process of identifying, describing, and evaluating the activities an organization performs. Activity analysis should produce four outcomes:

1. what activities are performed,
2. how many people perform the activities,
3. the time and resources required to perform the activities, and
4. an assessment of the value of the activities to the organization, including a recommendation to select and keep only those that add value.

Steps 1–3 have been described in Chapter 6. Those steps were critical for assigning costs. Step 4, determining the value-added content of activities, is concerned with cost reduction rather than cost assignment. Thus, this may be considered the most important part of activity analysis. Activities can be classified as *value-added* or *non-value-added*.

Value-Added Activities

Value-added activities are those activities necessary to remain in business. Value-added activities contribute to customer value and/or help meet an organization's needs. Activities that comply with legal mandates are value-added because they exist to meet organizational needs. Moreover, they add to customer value by allowing the business to continue operating so that the products and services desired by the customer can be obtained. Even though mandated activities are necessary, customers should insist that they be performed as efficiently as possible to reduce the cost impact on goods and services. Examples of mandated activities include those needed to comply with the reporting requirements of the CICA and the filing requirements of the CRA. The remaining activities in the firm are *discretionary*. Classifying discretionary activities as value-added is more of an art than a science and depends heavily on subjective judgment. However, it is possible to identify three conditions, which if simultaneously met, are sufficient to classify a discretionary activity as value-added. These conditions are as follows: (1) the activity produces a change of state, (2) the change of state was not achievable by preceding activities, and (3) the activity enables other activities to be performed.

For example, consider the production of metal components used in medical equipment. The first activity, gating, creates a wax mould replica of the final product. The next activity, shelling, creates a ceramic shell around the wax mould. After removing the wax, molten metal is poured into the resulting cavity. The shell is then broken to reveal the desired metal component. The gating activity is value-added because (1) it causes a change of state—unformed wax is transformed into a wax mould, (2) no prior activity was supposed to create this change of state, and (3) it enables the shelling activity to be performed. Similar comments hold for the shelling and pouring activities. The value-added properties are easy to see for operational activities like gating and shelling, but what about a more general activity like supervising production workers?

A managerial activity is specifically designed to manage other value-added activities—to ensure that they are performed in an efficient and timely manner. Supervision certainly satisfies the enabling condition. Is there a change in state? There are two ways of answering in the affirmative. First, supervising can be viewed as an enabling resource that is consumed by the operational activities that do produce a change of state. Thus, supervising is a secondary activity that serves as an input needed to help bring about the change of state expected for value-added primary activities. Second, it could be argued that the supervision brings order by changing the state from uncoordinated activities to coordinated activities.

Once value-added activities are identified, we can define value-added costs. **Value-added costs** are the costs to perform value-added activities with perfect efficiency. Implicit in this definition is the notion that value-added activities may contain nonessential actions that create unnecessary cost.

Non-Value-Added Activities

Non-value-added activities are unnecessary and are not valued by internal or external customers. Non-value-added activities often are those that fail to produce a change in state or those that replicate work because it wasn't done correctly the first time. Inspecting wax moulds, for example, is a non-value-added activity. Inspection is a *state-detection activity*, not a state-changing activity. (It tells us the state of the mould—whether or not it is of the right shape.) As a general rule, state-detection activities are not value-added. Now, consider the activity of recasting moulds that fail inspection. This recasting is designed to bring the mould from a nonconforming state to a conforming state. Thus, a change of state occurs. Yet, the activity is non-value-added because it *repeats* work; it is doing something that

should have been done by preceding activities, the first time the wax mould was cast. Thus, it is a *state-correction activity*. **Non-value-added costs** are costs that are caused either by non-value-added activities or by the inefficient performance of value-added activities. Because of increased competition, many firms are attempting to eliminate non-value-added activities and nonessential portions of value-added activities because they add unnecessary cost and impede performance. Therefore, activity analysis attempts to identify and eventually eliminate all unnecessary activities and, simultaneously, increase the efficiency of necessary activities.

Assessing the value content of activities enables managers to eliminate waste. As waste is eliminated, costs are reduced. Cost reduction *follows* the elimination of waste. Note the value of managing the *causes* of the costs rather than the costs themselves. Increasing the efficiency of a non-value-added activity is not a good long-term strategy. For example, training inspectors in sampling procedures may increase the efficiency of the activity of inspecting incoming components, but it is better to implement a supplier evaluation program that leads to suppliers that provide defect-free components, thus eliminating the need for inspection.

For example, **US Airways** implemented an activity-based cost management (ABCM) system to manage its in-house engine maintenance business unit. First, ABCM helped determine the cost of engine maintenance with increased accuracy. Second, ABCM provided operational and financial information that allowed work teams to identify opportunities for improvement. Thus, ABCM provided accurate cost information and simultaneously revealed opportunities for improvement. ABCM identified 410 activities—activities such as tear down, welding, waiting for tooling, and rework. Of the 410 activities, 47 were identified as non-value-added. The non-value-added activities were rank-ordered on the basis of activity cost, providing information about where the most significant process improvement opportunities were located. Root cause analysis was undertaken by the various work teams to determine the causes for the efforts being expended on the non-value-added activities. Once the root causes were identified, the teams took action to reduce or eliminate the non-value-added activities. The net effect was to produce $4.3 million in process savings per year.[1]

Examples of Non-Value-Added Activities Reordering parts, expediting production, and rework due to defective parts are examples of non-value-added activities. Other examples include warranty work, handling customer complaints, and reporting defects. Non-value-added activities can exist anywhere in the organization. In the manufacturing operation, five major activities are often cited as wasteful and unnecessary:

1. *Scheduling*. An activity that uses time and resources to determine when different products have access to processes (or when and how many setups must be done) and how much will be produced.
2. *Moving*. An activity that uses time and resources to move materials, work in process, and finished goods from one department to another.
3. *Waiting*. An activity in which materials or work in process use time and resources by waiting on the next process.
4. *Inspecting*. An activity in which time and resources are spent ensuring that the product meets specifications.
5. *Storing*. An activity that uses time and resources while a good or material is held in inventory.

None of these activities adds any value for the customer. Scheduling, for example, is not necessary if the company has learned how to produce on demand. Similarly, inspecting will not be necessary if the product is produced correctly the first time. The challenge of activity analysis is to find ways to produce the good without using any of these activities.

[1] Joe Donnelly and Dave Buchanan, "Implementation Lands $4.3 Million in Process Improvement Savings," *Better Management* (May 26, 2009) http://www.bettermanagement.com/library/library.aspx?l=536.

Ways of Cost Reduction through Activity Management Competitive conditions dictate that companies must deliver products the customers want, on time, and at the lowest possible cost. This means that an organization must continually strive for cost improvement. **Kaizen costing** is characterized by constant, incremental improvements to existing processes and products. Activity management is a fundamental part of kaizen costing. Activity management can reduce costs in four ways:[2]

1. Activity elimination
2. Activity selection
3. Activity reduction
4. Activity sharing

Activity elimination focuses on eliminating non-value-added activities. For example, the activity of expediting production seems necessary at times to ensure that customers' needs are met. Yet this activity is necessary only because of the company's failure to produce efficiently. By improving cycle time, a company may eventually eliminate the need for expediting. Cost reduction then follows.

Activity selection involves choosing among various sets of activities that are caused by competing strategies. Different strategies cause different activities. Different product design strategies, for example, can require significantly different activities. Activities, in turn, cause costs. Each product design strategy has its own set of activities and associated costs. All other things being equal, the lowest cost design strategy should be chosen. In a kaizen cost framework, *redesign* of existing products and processes can lead to a different, lower cost set of activities. Thus, activity selection can have a significant effect on cost reduction.

Activity reduction decreases the time and resources required by an activity. This approach to cost reduction should be aimed primarily at improving the efficiency of necessary activities or act as a short-term strategy for moving non-value-added activities toward the point of elimination. For example, by improving product quality, customer complaints should decrease and, consequently, the demand for handling customer complaints should decrease.

Activity sharing increases the efficiency of necessary activities by using economies of scale. Specifically, the quantity of the cost driver is increased without increasing the total cost of the activity itself. This lowers the per-unit cost of the cost driver and the amount of cost traceable to the products that consume the activity. For example, a new product can be designed to use components already being used by other products. By using existing components, the activities associated with these components already occur, and the company avoids the creation of a whole new set of activities.

Performance Measurement Analysis

Activity performance measurement is designed to assess how well an activity was performed and the results achieved. Measures of activity performance are both financial and nonfinancial and centre on three major dimensions: (1) efficiency, (2) quality, and (3) time. *Efficiency* is concerned with the relationship of activity outputs to activity inputs. For example, activity efficiency is improved by producing the same activity output with less inputs. Costs trending downward is evidence that activity efficiency is improving. *Quality* is concerned with doing the activity right the first time it is performed. If the activity output is defective, then the activity may need to be repeated, causing unnecessary cost and reduction in efficiency. The *time* required to perform an activity is also critical. Longer times usually mean more resource consumption and less ability to respond to customer demands. Time measures of performance tend to be nonfinancial, whereas efficiency and quality measures are both financial and nonfinancial.

[2] Peter B.B. Turney, "How Activity-Based Costing Helps Reduce Cost," *Journal of Cost Management* (Winter 1991): 29–35.

OBJECTIVE 3
Describe activity-based financial performance measurement.

Cost Dimension: Financial Measures of Activity Efficiency

Assessing activity performance should reveal the current level of efficiency and the potential for increased efficiency. Both financial and nonfinancial measures are used to reveal past performance and signal future potential gains in efficiency. Financial measures of activity performance are emphasized in this chapter, and nonfinancial measures are discussed in Chapter 15. **Financial measures** of performance should provide specific information about the dollar effects of activity performance changes. Thus, financial measures should indicate both potential and actual savings. Financial measures of activity efficiency include (1) value-and non-value-added activity costs, (2) trends in activity costs, (3) kaizen standard setting, (4) benchmarking, (5) activity flexible budgeting, and (6) activity capacity management.

Reporting Value- and Non-Value-Added Costs

Reducing non-value-added costs is one way to increase activity efficiency. A company's accounting system should distinguish between value-added costs and non-value-added costs because improving activity performance requires eliminating non-value-added activities and optimizing value-added activities. A firm should identify and formally report the value- and non-value-added costs of each activity. Highlighting non-value-added costs reveals the magnitude of the waste the company is currently experiencing, thus providing some information about the potential for improvement. This encourages managers to place more emphasis on controlling non-value-added activities. Progress can then be assessed by preparing trend and cost reduction reports. Tracking these costs over time permits managers to assess the effectiveness of their activity management programs.

Knowing the amount of costs saved is important for strategic purposes. For example, if an activity is eliminated, then the costs saved should be traceable to individual products. These savings can produce price reductions for customers, making the firm more competitive. Changing the pricing strategy, however, requires knowledge of the cost reductions realized by activity analysis. A cost-reporting system, therefore, is an important ingredient in an activity-based responsibility accounting system.

Value-added costs are the only costs that an organization should incur. The *value-added standard* calls for the complete elimination of non-value-added activities; for these activities, the optimal output is zero, with zero cost. The value-added standard also calls for the complete elimination of the inefficiency of activities that are necessary but inefficiently carried out. Hence, value-added activities also have an optimal output level. A **value-added standard**, therefore, identifies the optimal activity output. Identifying the optimal activity output requires activity output measurement.

Setting value-added standards does not mean that they will be (or should be) achieved immediately. The idea of continuous improvement is to move toward the ideal. Workers (teams) can be rewarded for improvement. Moreover, nonfinancial activity performance measures can be used to supplement and support the goal of eliminating non-value-added costs (these are discussed later in the chapter). Finally, measuring the efficiency of individual workers and supervisors is not the way to eliminate non-value-added activities. Remember, activities cut across departmental boundaries and are part of processes. Focusing on activities and providing incentives to improve processes is a more productive approach. Improving the process should lead to improved results.

By comparing actual activity costs with value-added activity costs, management can assess the level of activity inefficiency and the potential for improvement. To identify and calculate value- and non-value-added costs, output measures for each activity must be defined. Once output measures are defined, then value-added standard quantities (SQ) for each activity can be defined. Value-added costs can be computed by multiplying the value-added standard quantities by the price standard (SP).

Exhibit 14-2

Formulas for Value- and Non-Value-Added Costs

$$\text{Value-added costs} = SQ \times SP$$
$$\text{Non-value-added costs} = (AQ - SQ)SP$$

(This is in essence a quantity variance.)

where

SQ = The value-added output level for an activity
SP = The standard price per unit of activity output measure
AQ = The actual quantity used of flexible resources or the practical activity capacity acquired for committed resources

Non-value-added costs can be calculated as the difference between the actual level of the activity's output (AQ) and the value-added level (SQ), multiplied by the standard price. These formulas are presented in Exhibit 14-2. Some further explanation is needed.

For flexible resources (resources acquired as needed), AQ is the actual quantity of activity used. For committed resources (resources acquired in advance of usage), AQ represents the actual quantity of activity capacity acquired, as measured by the activity's practical capacity. This definition of AQ allows the computation of non-value-added costs for both variable and fixed activity costs. For fixed activity costs, SP is the budgeted activity costs divided by AQ, where AQ is practical activity capacity. Cornerstone 14-1 illustrates the power of these concepts.

Notice from the information in Cornerstone 14-1 that the value-added standards (SQ) for inspection and grinding call for their elimination. Ideally, there should be no defective moulds; by improving quality, changing production processes, and so on, inspection and grinding can eventually be eliminated. The cost report of Cornerstone 14-1 allows managers to see the non-value-added costs; as a consequence, it emphasizes the opportunity for improvement. By redesigning the products and reducing the number of parts required, purchase time can be reduced. By improving the moulding process and labour skill, management can reduce the demands for moulding time, inspection, and grinding. Thus, reporting value- and non-value-added costs at a point in time may trigger actions to manage activities more effectively. Once they see the amount of waste, managers may be induced to search for ways to improve activities and bring about cost reductions. Reporting these costs may also help managers improve planning, budgeting, and pricing decisions. For example, a manager might consider it possible to lower a selling price to meet a competitor's price if that manager can see the potential for reducing non-value-added costs to absorb the effect of the price reduction.

The Trend Report: Does a Decline of Non-Value-Added Costs Result in Cost Reduction?

As managers take actions to improve activities, do the cost reductions follow as expected? One way to answer this question is to compare the costs for each activity over time. The goal is activity improvement as measured by cost reduction. We should see a decline in non-value-added costs from one period to the next—provided the activity improvement initiatives are effective. The trend report will also reveal the amount of cost reduction still available. Cost reduction for value-added activities focuses on increasing the efficiency of these activities while the cost reduction goal for non-value-added activities is their eventual elimination. Cornerstone 14-2 provides an illustration of trend reporting of non-value-added costs.

CORNERSTONE 14-1

The HOW and WHY of Value- and Non-Value-Added Cost Reporting

Information:

A manufacturing firm has four activities: purchasing materials, moulding, inspecting moulds, and grinding imperfect moulds. Purchasing and moulding are necessary activities; inspection and grinding are unnecessary. The following data pertain to the four activities for the year ending 2013 (actual price per unit of the activity driver is assumed to be equal to the standard price):

Activity	Activity Driver	*SQ*	*AQ*	*SP*
Purchasing	Purchasing hours	20,000	24,000	$20
Moulding	Moulding hours	30,000	34,000	12
Inspecting	Inspection hours	0	6,000	15
Grinding	Number of units	0	5,000	6

Why:

A cost report that shows value and non-value-added costs allows managers to see the amount of waste, assess its materiality, and identify opportunities for improvement.

Required:

1. Prepare a cost report for the year ending 2013 that shows value-added costs, non-value-added costs, and total costs for each activity.
2. Explain why inspection and grinding are non-value-added activities.
3. ***What if*** purchasing cost is a step-fixed cost with each step being 2,000 hours whereas moulding cost is a variable cost? What is the implication for reducing the cost of waste for each activity?

Solution:

1.

Value- and Non-Value-Added Cost Report for the Year Ended 2013

Activity	Value-Added Costs	Non-Value-Added Costs	Total Costs
Purchasing	$400,000	$ 80,000	$ 480,000
Moulding	360,000	48,000	408,000
Inspecting	0	90,000	90,000
Grinding	0	30,000	30,000
Total	$760,000	$248,000	$1,008,000

2. Inspection is a state-detection activity, and grinding is a state-correction activity.
3. For purchasing, cost reduction occurs only when the actual demand for purchasing hours is reduced by each block of 2,000 hours. For moulding, each hour saved produces a savings of $12. Accordingly, cost savings will likely materialize more quickly for moulding than for purchasing.

The trend report in Cornerstone 14-2 reveals that more than half of the non-value-added costs have been eliminated. It also reveals that there is still ample room for improvement, but activity improvement so far has been successful. Reporting non-value-added costs, however, not only reveals cost reduction but also indicates

The HOW and WHY of Non-Value-Added Cost Trend Reporting

CORNERSTONE 14-2

Information:

See the information for Cornerstone 14-1. Assume that at the beginning of 2013, the moulding process was redesigned and the employees in Moulding were trained in a new work technique. By reducing the number of bad moulds, the firm hoped to significantly reduce waste for all four activities. Purchasing and Inspecting resources are purchased in steps of 2,000 hours. The other two activities are acquired as used and needed. At the end of 2013, the following results were reported for the four activities:

Activity	Activity Driver	*SQ*	*AQ*	*SP*
Purchasing	Purchasing hours	20,000	22,000	$20
Moulding	Moulding hours	30,000	32,000	12
Inspecting	Inspection hours	0	2,000	15
Grinding	Number of units	0	2,500	6

Why:

Comparing changes in non-value-added costs over time reveals where cost reductions have been achieved, allows managers to assess the effectiveness of improvement measures undertaken, and shows how much improvement potential remains.

Required:

1. Prepare a trend report that shows the non-value-added costs for each activity for 2012 and 2013 and the change in costs for the two periods. Discuss the report's implications.
2. Explain the role of activity reduction for both value-added activities and non-value-added activities.
3. ***What if*** at the end of 2013, the selling price of a competing product is reduced by $10 per unit? Assume that the firm produces and sells 10,000 units of its product and that its product is associated only with the four activities being considered. By virtue of the waste-reduction savings, can the competitor's price reduction be matched without reducing the unit profit margin of the product that prevailed at the beginning of the year?

Solution:

1.

Trend Report: Non-Value-Added Costs

Activity	2012	2013*	Change
Purchasing	$ 80,000	$ 40,000	$ 40,000
Moulding	48,000	24,000	24,000
Inspecting	90,000	30,000	60,000
Grinding	30,000	15,000	15,000
Total	$248,000	$109,000	$139,000

*Since the reduction for the purchasing and inspection were in multiples of 2,000, the cost savings is simply *SP* multiplied by the reduction in *AQ*.

The trend report shows a significant reduction in non-value-added costs, validating the improvement actions taken.

2. For value-added activities, the non-value-added component is usually the result of using more of the activity than should be used; thus, activity

CORNERSTONE 14-2 *(continued)*

reduction is the objective for improving activity efficiency. For non-value-added activities, activity reduction is an intermediate step that ultimately will lead to activity elimination. Depending on the nature of the resources consumed by the activity, activity reduction can also lead to cost reductions.

3. From Requirement 1, the savings per unit of product are $13.90 ($139,000/10,000), indicating that the competitor's price reduction can be matched (or beat) without changing the unit profit margin that existed at the beginning of the year.

where the reduction occurred. It provides managers with information on how much potential for cost reduction remains, assuming that the value-added standards remain the same. Value-added standards, however, like other standards, are not cast in stone. New technology, new designs, and other innovations can change the nature of activities performed. As new ways for improvement surface, value-added standards can change. Managers should not become content but should continually seek higher levels of efficiency.

Drivers and Behavioural Effects

Activity output measures are needed to compute and track non-value-added costs. Reducing a non-value-added activity should produce a reduction in the demand for the activity and, therefore, a reduction in the activity output measures. If a team's performance is affected by its ability to reduce non-value-added costs, then the selection of activity drivers (as output measures) and the way the drivers are used can affect behaviour. For example, if the output measure for setup costs is chosen as setup time, an incentive is created for workers to reduce setup time. Since the value-added standard for setup costs calls for their complete elimination, then the incentive to drive setup time to zero is compatible with the company's objectives, and the induced behaviour is beneficial.

Suppose, however, that the objective is to reduce the number of unique parts a company processes, thus reducing the demand for activities such as purchasing and incoming inspection. If the costs of these activities are assigned to products based on the number of parts, the incentive created is to reduce the number of parts in a product. Yet if too many parts are eliminated, the functionality of the product may be reduced to a point where its marketability is adversely affected. Identifying the value-added standard number of parts for each product through the use of functional analysis can discourage this type of behaviour.[3] Designers can then be encouraged to reduce the non-value-added costs by designing to reach the value-added standard number of parts. The standard has provided a concrete objective and defined the kind of behaviour that the incentive allows.

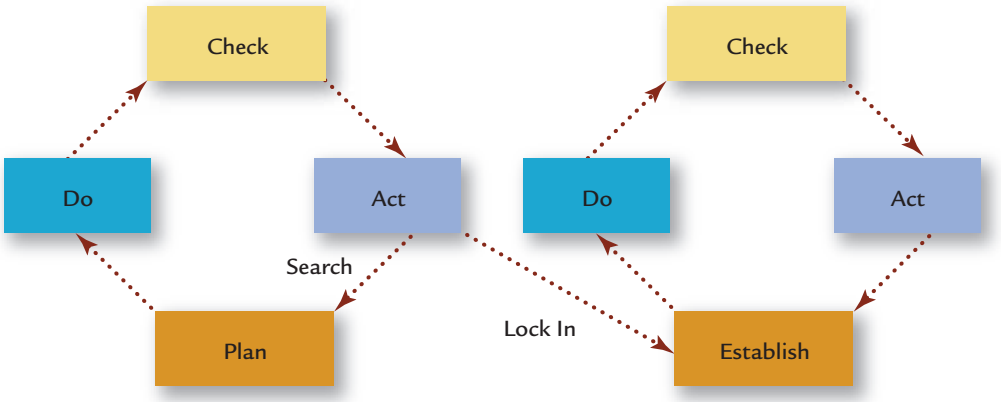
Kaizen Costing

Kaizen costing is concerned with reducing the costs of *existing* products and processes. In operational terms, this translates into reducing non-value-added costs. Controlling this cost reduction process is accomplished through the repetitive use of two major subcycles: (1) the kaizen or continuous improvement cycle and (2) the maintenance cycle. The kaizen subcycle is defined by a Plan-Do-Check-Act sequence. If a company is emphasizing the reduction of non-value-added costs, the amount of improvement planned for the coming period (month, quarter, etc.) is set (the *Plan* step). A **kaizen standard** reflects the planned improvement for the upcoming period. The planned improvement is assumed to be attainable, and kaizen standards are a type of currently attainable standard. Actions are taken to implement the planned improvements (the *Do* step). Next, actual results (e.g., costs) are compared with the

[3] Functional analysis compares the price customers are willing to pay for a particular product function with the cost of providing that function.

Exhibit 14-3

Kaizen Cost Reduction Process



kaizen standard to provide a measure of the level of improvement attained (the *Check* step). Setting this new level as a minimum standard for future performance locks in the realized improvements and simultaneously initiates the maintenance cycle and a search for additional improvement opportunities (the *Act* step). The maintenance cycle follows a traditional Establish-Do-Check-Act sequence. A standard is set based on prior improvements (locking in these improvements). Next, actions are taken (the *Do* step) and the results checked to ensure that performance conforms to this new level (the *Check* step). If not, then corrective actions are taken to restore performance (the *Act* step). The kaizen cost reduction process is summarized in Exhibit 14-3. Cornerstone 14-3 demonstrates an application of kaizen costing.

In some cases, companies have formalized the process of revising standards. For example, **Shionogi Pharmaceuticals** first assesses whether the improvements are attributable to kaizen activities or to random fluctuations. If kaizen activities are the source, Shionogi then evaluates the *sustainability* of the kaizen improvements. Improvements are locked in through revision of standards only if the improvements are judged to be sustainable.[4]

Benchmarking

Benchmarking is complementary to kaizen costing and activity-based management, and it can be used as a search mechanism to identify opportunities for improvement. **Benchmarking** uses best practices found within and outside the organization as the standard for evaluating and improving activity performance. The objective of benchmarking is to become the best at performing activities and processes (thus, benchmarking represents an important activity management methodology). The approach certainly seems to have considerable merit. A recent APQC study revealed that benchmarking returns ranged from $1.5 million to $189.4 million.[5] Interestingly, there was a direct correlation between the level of return and the degree of senior management support.

Internal Benchmarking Benchmarking against internal operations is called *internal benchmarking*. Within an organization, different units (e.g., different plant sites) that perform the same activities are compared. The unit with the best performance for a given activity sets the standard. Other units then have a target to meet or exceed. Furthermore, the best practices unit can share information with other units on how it has achieved its superior results. Internal benchmarking has several advantages. First, a significant amount of information is often readily available that can be shared throughout the

[4] Robin Cooper, *When Lean Enterprises Collide* (Boston: Harvard Business School Press, 1995).

[5] Kate Vitasek and Karl Mandrodt, *Benchmarking: Prerequisite for Best-In-Class Supply Chains*, an APQC white paper (see knowledge base section)(February 5, 2007), http://www.apqc.org/portal/apqc/ksn?paf_gear_id=contentgearhome&paf_dm=full&pageselect=detail&docid=129520, accessed May 27, 2009.

CORNERSTONE 14-3

The HOW and WHY of Kaizen Costing

Information:

An automotive parts division has a grinding activity for the subassemblies that it produces. Activity output is measured using grinding hours. The value-added standard (*SQ*) for this activity is zero grinding hours. On January 1, at the beginning of the fiscal year, eight grinding hours were allowed per batch (which almost always corresponded to the actual grinding hours used). The standard wage rate is $18 per grinding hour. During January, a new procedure for production of the subassemblies was developed with the expectation that the demand for grinding would be reduced by 25 percent. The new procedure was implemented in February and expectations concerning the effect on the grinding activity were met.

Why:

Kaizen costing has the objective of continuously improving the efficiency of activities and processes. It can be characterized as a *dynamic* standard costing system. Maintenance standards are revised based on achieved, sustainable improvements produced by the kaizen subcycle.

Required:

1. What are the maintenance standard for grinding hours and the associated expected cost at the beginning of February? The kaizen standard and expected associated cost?
2. What are the maintenance standard for grinding hours and the associated cost at the end of February? Explain. What is the next step in the kaizen cost reduction process?
3. ***What if*** the new procedure implemented in February produced a 20 percent reduction instead of a 25 percent reduction? What would the new maintenance standard and cost be?

Solution:

1. Maintenance standard: 8 hours per batch; Expected cost per batch: $144 (8 × $18); Kaizen standard: 6 hours per batch (0.75 × 8); Expected cost per batch: $108 (6 × $18).
2. Maintenance standard: 6 hours per batch; Expected cost per batch: $108 (6 × $18). After determining that the suggested improvement works and is sustainable, the new level of performance is locked in by revising the maintenance standard from eight hours to six hours. The next step is to search for another improvement opportunity that will then produce a new kaizen standard and expected batch cost. The ultimate objective is to eliminate all the non-value-added cost through a series of kaizen improvements.
3. You lock in the level actually achieved by the suggested improvement approach. In this case, the maintenance standard would be 6.4 hours (0.80 × 8) and the standard batch cost $115.20 (6.4 × $18).

organization. Second, immediate cost reductions are often realized. Third, the best internal standards that spread throughout the organization become the benchmark for comparison against external benchmarking partners. This last advantage also suggests the major disadvantage of internal benchmarking. Specifically, the best internal performance may fall short of what others are doing, particularly direct competitors.

There are numerous examples of the benefits of internal benchmarking.[6] **Thomson Corporation** collected and broadcast best practices through internal benchmarking

[6] Frank Jossi, "Take a Peek Inside," *HRMagazine* (June 2002): 46–52.

throughout the company and saved $200 million in one year. **Chevron** saved $150 million by transferring energy use management techniques throughout the company. **Public Service Enterprise Group** used internal benchmarking to improve the process for ripping up a street, repairing a line, backfilling the hole, and repaving the area. The improvement dropped costs from an average of $2,200 to just $200 per incident.

External Benchmarking Benchmarking that involves comparison with others outside the organization is called *external benchmarking*. The three types of external benchmarking are competitive benchmarking, functional benchmarking, and generic benchmarking. Competitive benchmarking is a comparison of activity performance with direct competitors. The main problem with competitive benchmarking is that it is very difficult to obtain information beyond that found in the public domain. At times, however, it is possible. **The Ritz-Carlton**, for example, dramatically improved its housekeeping process by studying the best practices of a competitor.[7] Functional benchmarking is a comparison with firms that are in the same industry but do not compete in the same markets. For example, a Japanese communications firm might be able to compare its customer service process with that of **Bell Canada**. Generic benchmarking studies the best practices of noncompetitors outside a firm's industry. Certain activities and processes are common to all organizations. If superior external best practices can be identified, then they can be used as standards to motivate internal improvements. For example, **Verizon** improved its field service process by studying the field service process of an elevator company.[8]

Activity Flexible Budgeting

Activity flexible budgeting is the prediction of what activity costs will be as activity output changes. Variance analysis within an activity framework makes it possible to improve traditional budgetary performance reporting. It also enhances the ability to manage activities.

In a unit-based approach, budgeted costs for the actual level of activity are obtained by assuming that a single unit-based driver (units of product or direct labour hours) drives all costs. A cost formula is developed for each cost item as a function of units produced or direct labour hours. Exhibit 14-4 presents a unit-based flexible budget based on direct labour hours. If, however, costs vary with respect to more than one driver and the drivers are not highly correlated with direct labour hours, then the predicted costs can be misleading.

Exhibit 14-4

Flexible Budget: Direct Labour Hours

	Cost Formula		Direct Labour Hours	
	Fixed	Variable	10,000	20,000
Direct materials	—	$10	$100,000	$200,000
Direct labour	—	8	80,000	160,000
Maintenance	$ 20,000	3	50,000	80,000
Machining	15,000	1	25,000	35,000
Inspections	120,000	—	120,000	120,000
Setups	50,000	—	50,000	50,000
Purchasing	220,000	—	220,000	220,000
Total	$425,000	$22	$645,000	$865,000

[7] Robert C. Camp, *Business Process Benchmarking* (Milwaukee, WI: ASQC Quality Press, 1995): 273.
[8] Ibid.

The solution, of course, is to build flexible budget formulas for more than one driver. Cost estimation procedures (high-low method, the method of least squares, and so on) can be used to estimate and validate the cost formulas for each activity. This multiple cost-formula approach allows managers to predict more accurately what costs should be for different levels of activity usage, as measured by the activity output measure. These costs can then be compared with the actual costs to help assess budgetary performance. Exhibit 14-5 provides an example of an activity flexible budget. Notice that the budgeted amounts for direct materials and direct labour are the same as those reported in Exhibit 14-4; they use the same activity output measure. The budgeted amounts for the other items differ significantly from the traditional amounts because the activity output measures differ.

Assume that the first activity level for each driver in Exhibit 14-5 corresponds to the actual activity usage levels. Exhibit 14-6 compares the budgeted costs for the actual activity usage levels with the actual costs. One item is on target, and the other six items are mixed. The net outcome is a favourable variance of $21,500.

The performance report in Exhibit 14-6 compares total budgeted costs for the actual level of activity with the total actual costs for each activity. It is also possible to compare the actual fixed activity costs with the budgeted fixed activity costs, and the actual variable activity costs with the budgeted variable costs. Moreover, Exhibit 14-5 presents the budget formulas for each activity without any indication of how these formulas can be derived. Cornerstone 14-4 demonstrates how an activity-based flexible budget formula can be derived and then used for performance reporting with a detailed breakdown of fixed and variable activity costs.

Exhibit 14-5

Activity Flexible Budget

DRIVER: DIRECT LABOUR HOURS				
	Formula		Level of Activity	
	Fixed	Variable	10,000	20,000
Direct materials	—	$10	$100,000	$200,000
Direct labour	—	8	80,000	160,000
Subtotal	—	$18	$180,000	$360,000
DRIVER: MACHINE HOURS				
	Fixed	Variable	8,000	16,000
Maintenance	$20,000	$5.50	$64,000	$108,000
Machining	15,000	2.00	31,000	47,000
Subtotal	$35,000	$7.50	$95,000	$155,000
DRIVER: NUMBER OF SETUPS				
	Fixed	Variable	25	30
Inspections	$80,000	$2,100	$132,500	$143,000
Setups	—	1,800	45,000	54,000
Subtotal	$80,000	$3,900	$177,500	$197,000
DRIVER: NUMBER OF ORDERS				
	Fixed	Variable	15,000	25,000
Purchasing	$211,000	$1	$226,000	$236,000
Total			$678,500	$948,000

Exhibit 14-6

*Activity-Based Performance Report**

	Actual Costs	Budgeted Costs	Budget Variance
Direct materials	$101,000	$100,000	$ 1,000 U
Direct labour	80,000	80,000	—
Maintenance	55,000	64,000	9,000 F
Machining	29,000	31,000	2,000 F
Inspections	125,500	132,500	7,000 F
Setups	46,500	45,000	1,500 U
Purchasing	220,000	226,000	6,000 F
Total	$657,000	$678,500	$21,500 F

*Activity levels of drivers: 10,000 direct labour hours, 8,000 machine hours, 25 setups, and 15,000 orders.

As Cornerstone 14-4 shows, breaking each variance into fixed and variable components provides more insight into the source of the variation in planned and actual expenditures. Activity budgets also provide valuable information about capacity usage.

Activity Capacity Management

Activity capacity is the number of times an activity can be performed. For example, consider inspecting finished goods as the activity. A sample from each batch is taken to determine the batch's overall quality. The demand for the inspection activity determines the amount of activity capacity. For instance, suppose that the number of batches inspected measures activity output. Now, suppose that 60 batches are scheduled to be produced. Then, the activity capacity is 60 batches. Finally, assume that a single inspector can inspect 20 batches per year. Thus, three inspectors must be hired to provide the necessary capacity. If each inspector is paid a salary of $40,000, the budgeted cost of the activity capacity is $120,000. This is the cost of the resources (labour) acquired in advance of usage. The budgeted activity rate is $2,000 per batch ($120,000/60).

Several questions relate to activity capacity and its cost. First, what *should* the activity capacity be? The answer to this question provides the ability to measure the amount of improvement possible. Second, how much of the capacity acquired was actually used? The answer to this question signals a nonproductive cost and, at the same time, an opportunity for capacity reduction and cost savings.

Capacity Variances

There are two capacity variances: the *activity volume variance* and the *unused capacity variance*. The **activity volume variance** is the difference between the actual quantity capacity, (AQ) and the value-added standard quantity of activity that should be used (SQ), multiplied by the budgeted activity rate (SP):

$$\text{Activity volume variance} = (AQ - SQ)SP$$

The volume variance in this framework represents the non-value-added cost of the inspection activity. It measures the amount of improvement that is possible through analysis and management of activities. However, since the supply of the activity must be acquired in advance of usage (usually in blocks or steps, for example, one inspector at a time), it is also important to measure the current demand for the activity (actual usage). If AQ is more than SQ ($AQ > SQ$), then the variance is unfavourable (indicating that non-value-added cost is present).

The **unused capacity variance** is defined as the difference between actual quantity capacity available (AQ) and activity usage (AU), multiplied by the budgeted activity rate (SP):

$$\text{Unused capacity variance} = (AU - AQ)SP$$

CORNERSTONE 14-4

The HOW and WHY of Activity-Based Flexible Budgeting

Information:

Thomas Company has a "maintaining equipment" activity and wants to develop a flexible budget formula for the activity. The following resources are used by the activity:

- Three portable diagnostic units, with a lease cost of $8,000 per year per unit
- Three maintenance personnel each paid a salary of $45,000 per year (A total of 6,000 maintenance hours are supplied by the three workers.)
- Parts and supplies: $100 per diagnosis
- Maintenance hours: Four hours used per diagnosis

During the year, the activity operated at 80 percent of capacity and incurred the following actual activity and resource costs:

- Lease cost: $24,000
- Salaries: $145,000
- Parts and supplies: $135,000

Why:

The variable cost component for each activity corresponds to resources acquired as needed (flexible resources), and the fixed cost component corresponds to resources acquired in advance of usage (committed resources). Performance reporting compares the actual activity costs with the costs budgeted for the actual activity level (for a given time period).

Required:

1. Prepare a flexible budget formula for the maintenance activity using maintenance hours as the driver.
2. Prepare a performance report for the maintenance activity.
3. ***What if*** maintenance workers were hired through outsourcing and paid $20 per hour (the diagnostic units are still leased by Thomas)? Repeat Requirement 1 for the outsourcing case.

Solution:

1. Acquired in advance of usage:

Diagnostic equipment	$ 24,000 (3 × $8,000)
Maintenance workers	135,000 (3 × $45,000)
Total fixed costs	$159,000

Acquired as needed:

Parts and supplies: $100/4 = $25 per maintenance hour (X)

Formula: Maintenance cost = $159,000 + 25X$

2.

Activity-Based Performance Report

Activity	Actual Cost	Budgeted Cost (80% level)*	Budget Variance
Maintenance:			
Fixed cost	$169,000	$159,000	$10,000 U
Variable cost	135,000	120,000	15,000 U

*$159,000 (fixed); $25 × 0.80 × 6,000 (variable)

3. Maintenance cost = $24,000 + 45X$ (The cost of diagnostic equipment is fixed; the variable cost is the $20 per hour of contract labour plus the $25 per hour for parts and supplies.)

The unused capacity goal is to reduce the demand for the activity until such time as the unused capacity variance equals the volume variance. When capacity exceeds demand, management can take steps to reduce it. Why? Because the activity volume variance is a non-value-added cost and the unused activity variance measures the progress made in reducing this non-value-added cost. Thus, the variance is labelled as favourable. Cornerstone 14-5 shows the calculation and usage of the capacity variances.

In Cornerstone 14-5, we know that the supply of inspection resources is greater than its usage. Assume that this unused capacity exists because management has been engaged in a quality-improvement program that has reduced the need to inspect certain batches of products. When the cost of unused capacity reaches $40,000, this difference between the supply of the inspection resources and their usage should impact future spending plans. Furthermore, because of the quality-improvement program, we can expect this difference to persist and even become greater (with the ultimate goal of reducing the cost of inspection activity to zero). Management now must be willing to exploit the unused capacity it has created. Essentially, when the savings reach the price of one inspector, activity availability can be reduced; thus, the spending on inspection can be decreased. A manager can use several options to achieve this outcome. When the inspection demand has been reduced to at most 4,000 hours, the company needs only two full-time inspectors. The extra inspector could be permanently reassigned to an activity where resources are in short supply. If reassignment is not feasible, the company should lay off the extra inspector.

This example illustrates an important feature of activity capacity management. Activity improvement can create unused capacity, but managers must be willing and able to make the tough decisions to reduce resource spending on the redundant resources to gain the potential profit increase. Profits can be increased by reducing resource spending or by transferring the resources to other activities that will generate more revenues.

Implementing Activity-Based Management

OBJECTIVE 4
Discuss the implementation issues associated with an activity-based management system.

Activity-based management (ABM) is a more comprehensive system than an activity-based costing (ABC) system. ABM adds a process view to the cost view of ABC. ABM encompasses ABC and uses it as a major source of information. ABM can be viewed as an information system that has the broad objectives of (1) improving decision making by providing accurate cost information and (2) reducing costs by encouraging and supporting process value analysis (PVA) and continuous improvement efforts. The first objective is the domain of ABC, while the second objective belongs to ABM. The second objective requires more detailed data than ABC's objective of improving the accuracy of costing assignments. If a company intends to use both ABC and PVA, then its approach to implementation must be carefully conceived. For example, if ABC creates aggregate cost pools based on homogeneity, much of the detailed activity information may not be needed. Yet for PVA, this detail must be retained. Clearly, how to implement an ABM system is a major consideration. Exhibit 14-7 provides a representation of an ABM implementation model.

Discussion of the ABM Implementation Model

The model in Exhibit 14-7 shows that the overall objective of ABM is to improve a firm's profitability, an objective achieved by identifying and selecting opportunities for improvement and using more accurate information to make better decisions. Root cause analysis, for example, reveals opportunities for improvement. By identifying non-value-added costs, priorities can be established based on the initiatives that offer the most cost reduction. Furthermore, the potential cost reduction itself is measured by ABC calculations.

Exhibit 14-7 also reveals that 10 steps define an ABM implementation: two common steps and four that are associated with either ABC or PVA. The PVA steps have been discussed extensively in this chapter, whereas the ABC steps were discussed in

CORNERSTONE 14-5

The HOW and WHY of Activity Capacity Management

Information:

Inspecting finished goods is the activity. Activity output is measured by inspection hours. The following data pertain to the activity for the most recent year:

Activity supply: 6,000 hours (three inspectors @ 2,000 hours per year)
Inspector cost (salary): $40,000 per year
Actual usage: 4,500 inspection hours

Why:

The volume variance measures the non-value-added cost of the inspection activity and the unused capacity variance measures the progress toward reducing the activity waste. Knowing these two variances is valuable information for managing activity capacity.

Required:

1. Calculate the volume variance and explain its significance.
2. Calculate the unused capacity variance and explain its use.
3. ***What if*** the actual usage is 3,500 hours? What effect will this have on capacity management?

Solution:

1. Inspection generally is classified as a non-value-added activity. Thus,

$$\begin{aligned}\text{Volume variance} &= (AQ - SQ)SP \\ &= (6{,}000 - 0)\$20^* \\ &= \$120{,}000\ \text{U}\end{aligned}$$

*Activity rate = ($40,000 × 3)/6,000

The volume variance is a measure of the non-value-added cost. In this case, the entire cost of the activity is non-value-added. Management should strive to find ways to reduce and eventually eliminate the activity.

2. $$\begin{aligned}\text{Unused capacity variance} &= (AU - AQ)SP \\ &= (4{,}500 - 6{,}000)\$20 \\ &= \$30{,}000\ \text{F}\end{aligned}$$

The demand for the activity has been reduced; however, the reduction is not sufficient to produce a reduction in activity spending.

3. Recalculating the unused capacity variance:

$$\begin{aligned}\text{Unused capacity variance} &= (AU - AQ)SP \\ &= (3{,}500 - 6{,}000)\$20 \\ &= \$50{,}000\ \text{F}\end{aligned}$$

At this level of demand, only two inspectors are needed to meet the demand; thus, resource spending can be reduced by $40,000.

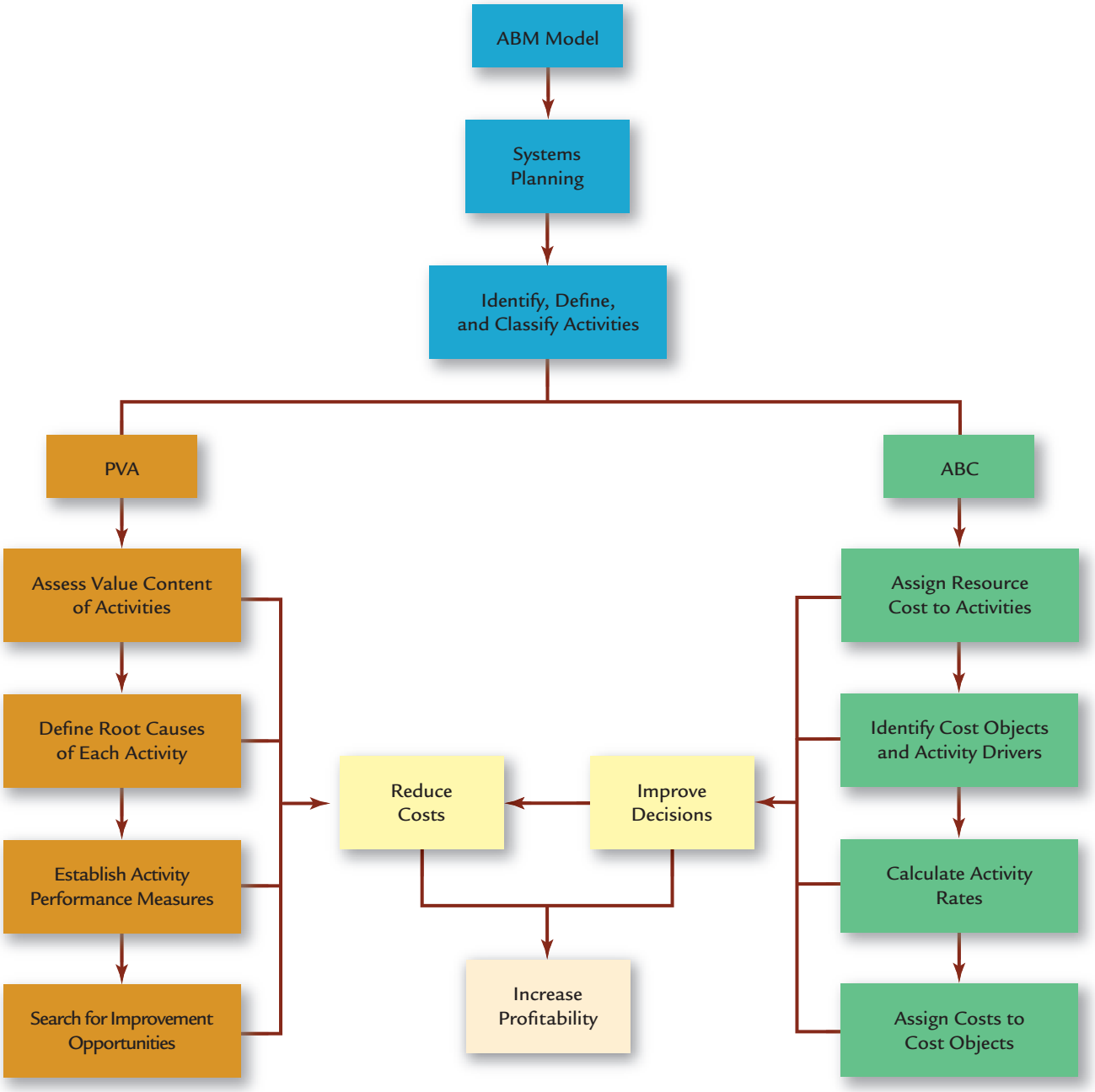
Chapter 6. The two common steps are (1) systems planning and (2) activity identification, definition, and classification.

Systems Planning Systems planning provides the justification for implementing ABM and addresses the following issues:

1. The purpose and objectives of the ABM system
2. The organization's current and desired competitive position

Exhibit 14-7

ABM Implementation Model



3. The organization's business processes and product mix
4. The timeline, assigned responsibilities, and resources required for implementation
5. The ability of the organization to implement, learn, and use new information

To convince operating personnel that ABM is of great value, the objectives of an ABM system must be carefully identified and related to the firm's desired competitive position, business processes, and product mix. The broad objectives have already been mentioned (improving accuracy and continuous improvement); however, it is also necessary to develop specific desired outcomes associated with each of these two

objectives. For example, one specific outcome is that of changing the product mix based on more accurate costs (with the expectation that profits will increase). Another specific outcome is that of improving the firm's competitive position by increasing process efficiency through elimination of non-value-added activities. Planning also entails establishing a timeline for the implementation project, assigning specific responsibilities to individuals or teams, and developing a detailed budget. Although all five issues listed are important, the information usage issue deserves special attention. Successful implementation is strongly dependent on the organization's ability to learn how to use the new information provided by ABM. Users must be convinced that this new information can solve specific problems. They also need to be trained to use activity-based costing information to produce better decisions, and they need to understand how ABM drives and supports continuous improvement.

Identifying, defining, and classifying activities require more attention for ABM than for ABC. The activity dictionary should include a detailed listing of the tasks that define each activity. Knowing the tasks that define an activity can be very helpful for improving the efficiency of value-added activities. Classification of activities also allows ABM to connect with other continuous improvement initiatives such as JIT, total quality management, and total environmental quality cost management. For example, identifying quality-related and environmental activities enables management to focus attention on the non-value-added activities of the quality and environmental categories. ABC also provides a more complete understanding of the effect that quality and environmental costs have on products, processes, and customers. It is important to realize that successful implementation requires time and patience. This is especially true when it comes to using the new information provided by an ABM system. For example, one survey revealed that it takes an average of 3.1 years for non-accounting personnel to grow accustomed to using ABC information.[9]

Why ABM Implementations Fail

ABM can fail as a system for a variety of reasons. One of the major reasons is the lack of support of higher-level management. Not only must this support be obtained before undertaking an implementation project, but it must also be maintained. Loss of support can occur if the implementation takes too long or the expected results do not materialize.

Results may not occur as expected because operating and sales managers do not have the expertise to use the new activity information. Thus, significant efforts to train and educate need to be undertaken. Advantages of the new data need to be spelled out carefully, and managers must be taught how these data can be used to increase efficiency and productivity.

Resistance to change should be expected; it is not unusual for managers to receive the new cost information with skepticism. Showing how this information can enable them to be better managers should help to overcome this resistance. Involving nonfinancial managers in the planning and implementation stages may also reduce resistance and secure the required support.

Failure to integrate the new system is another major reason for an ABM system breakdown. The probability of success is increased if the ABM system is not in competition with other improvement programs or the official accounting system. It is important to communicate the concept that ABM complements and enhances other improvement programs. Moreover, it is important that ABM be integrated to the point that activity costing outcomes are not in direct competition with the traditional accounting numbers. Managers may be tempted to continue using the traditional accounting numbers in lieu of the new data.

[9] Kip R. Krumwiede, "ABC: Why It's Tried and How It Succeeds," *Management Accounting* (April 1998): 32–38.

Activity-Based Responsibility Accounting

OBJECTIVE 5

Explain how activity-based management is a form of responsibility accounting, and tell how it differs from financial-based responsibility accounting.

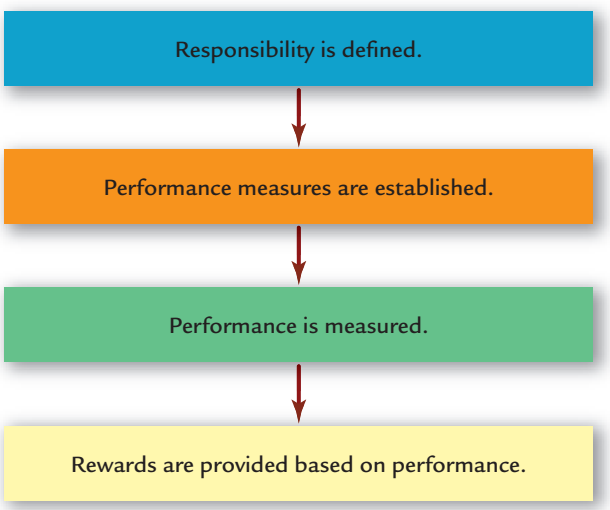
Responsibility accounting is a fundamental tool of managerial control and is defined by four essential elements: (1) assigning responsibility, (2) establishing performance measures or benchmarks, (3) evaluating performance, and (4) assigning rewards. The objective of responsibility accounting is to influence behaviour in such a way that individual and organizational initiatives are aligned to achieve a common goal or goals. Exhibit 14-8 illustrates the responsibility accounting model.

A particular responsibility accounting system is defined by how the four elements in Exhibit 14-8 are defined. Three types of responsibility accounting systems have evolved over time: *financial-based*, *activity-based*, and *strategic-based*. All three are found in practice today. Essentially, firms choose the responsibility accounting system that is compatible with the requirements and economics of their particular operating environment. Firms that operate in a stable environment with standardized products and processes and low competitive pressures will likely find the less complex, financial-based responsibility accounting systems to be quite adequate. As organizational complexity increases and the competitive environment becomes much more dynamic, activity-based and strategic-based systems are likely to be more suitable. Strategic-based responsibility accounting systems are discussed in Chapter 15.

The responsibility accounting system for a stable environment is referred to as *financial-based responsibility accounting*. A **financial-based responsibility accounting system** assigns responsibility to organizational units and expresses performance measures in financial terms. It emphasizes a financial perspective. *Activity-based responsibility accounting*, on the other hand, is the responsibility accounting system developed for those firms operating in continuous improvement environments. **Activity-based responsibility accounting** assigns responsibility to processes and uses both financial and nonfinancial measures of performance, thus emphasizing both financial and process perspectives. A comparison of each of the four elements of the responsibility accounting model for each responsibility system reveals the key differences between the two approaches.

Exhibit 14-8

The Responsibility Accounting Model



Assigning Responsibility

Exhibit 14-9 lists the differences in responsibility assignments between the two systems. Financial-based responsibility accounting focuses on *functional* organizational units and individuals. First, a responsibility centre is identified. This centre is typically an organizational unit such as a plant, department, or production line. Whatever the functional unit is, responsibility is assigned to the individual in charge. Responsibility is defined in financial terms (e.g., costs). Emphasis is on achieving optimal financial results at the local level (i.e., organizational unit level). Exhibit 14-9 reveals that in an activity or process-based responsibility system, the focal point changes from units and individuals to processes and teams. Systemwide optimization is the emphasis. Also, financial responsibility continues to be vital. The reasons for the change in focus are simple. In a continuous improvement environment, the financial perspective translates into continuously *enhancing revenues*, *reducing costs*, and *improving asset utilization*. Creating this continuous growth and improvement requires an organization to constantly improve its capabilities of delivering value to customers and shareholders. A process perspective is chosen instead of an organizational-unit perspective because processes are the *sources* of value for customers and shareholders and because they are the key to achieving an organization's financial objectives. The customer can be internal or external to the organization. Procurement, new product development, manufacturing, and customer service are examples of processes.

Since processes are the way things are done, changing the way things are done means changing processes. Three methods can change the way things are done: *process improvement*, *process innovation*, and *process creation*.

Process improvement refers to incremental and constant increases in the efficiency of an existing process. For example, **Medtronic Xomed**, a manufacturer of surgical products (for ears, nose, and throat specialists), improved its processes by providing written instructions telling workers the best way to do their jobs. Over a three-year period, the company reduced rework by 57 percent, reduced scrap by 85 percent, and experienced a 38 percent reduction in the cost of its shipped products.[10] Activity-based management is particularly useful for bringing about process improvements. Processes are made up of activities that are linked by a common objective. Listing these activities and classifying them as value-added or non-value-added immediately suggests a way to make the process better: eliminate the non-value-added activities.

Process innovation (business re-engineering) refers to the performance of a process in a radically new way with the objective of achieving dramatic improvements in response time, quality, and efficiency. **IBM Credit**, for example, radically redesigned its credit approval process and reduced its time for preparing a quote from seven days to one; similarly, **Federal-Mogul**, a parts manufacturer, used process innovation to reduce development time for part prototypes from 20 weeks to 20 days.[11]

Exhibit 14-9

Responsibility Assignments Compared

Financial-Based Responsibility	Activity-Based Responsibility
1. Organizational units	1. Processes
2. Local operating efficiency	2. Systemwide efficiency
3. Individual accountability	3. Team accountability
4. Financial outcomes	4. Financial outcomes

[10] William Leventon, "Manufacturers Get Lean to Trim Waste," *Medical Device & Diagnostic Industry* (September 2004), http://www.devicelink.com/mddi/archive/04/09/016.html.

[11] Thomas H. Davenport, *Process Innovation* (Boston: Harvard Business School Press, 1993): 2.

Process creation refers to the installation of an entirely new process with the objective of meeting customer and financial objectives. **Chemical Bank**, for example, identified three *new* internal processes: understanding customer segments, developing new products, and cross-selling the product line.[12] These new internal processes were viewed as critical by the bank's management for improving the customer and profit mix and creating an enabled organization. It should be mentioned that process creation does not mean that the process has to be *original* to the organization. It means that it is *new* to the organization. For example, developing new products is a process common to many organizations but evidently was new to Chemical Bank.

Many processes cut across functional boundaries. This facilitates an integrated approach that emphasizes the firm's value-chain activities. It also means that cross-functional skills are needed for effective process management. Teams are the natural outcome of this process management requirement. Teams also improve the quality of work life by fostering friendships and a sense of belonging. Process improvement, innovation, and creation require significant group activity (and support) and cannot be carried out effectively by individuals. **General Electric**, **Xerox**, **Martin Marietta Materials**, and **Aetna** have all begun to use teams as their basic work unit.[13]

Establishing Performance Measures

Once responsibility is defined, performance measures must be identified and standards set to serve as benchmarks for performance measurement. Exhibit 14-10 provides a comparison of the two systems' approach to the task of defining performance measures. According to Exhibit 14-10, budgeting and standard costing are the cornerstones of the benchmark activity for a financial-based system. This, of course, implies that performance measures are objective and financial in nature. Furthermore, they tend to support the status quo and are relatively stable over time. Exhibit 14-10 reveals some striking differences for firms operating in a continuous improvement environment.

First, performance measures are process-oriented and, thus, must be concerned with process attributes such as process time, quality, and efficiency. Second, performance measurement standards are structured to support change. Therefore, standards are dynamic in nature. They change to reflect new conditions and new goals and to help maintain any progress that has been realized. For example, standards can be set that reflect some desired level of improvement for a process. Once the desired level is achieved, the standard is changed to encourage an additional increment of improvement. In an environment where constant improvement is sought, standards cannot be static. Third, optimal standards assume a vital role. They set the ultimate achievement target and, thus, identify the potential for improvement. Finally, standards should reflect the value added by individual activities and processes. Identifying a value-added standard for each activity is much more ambitious than the traditional financial responsibility system. It expands control to include the entire organization.

Exhibit 14-10

Performance Measures Compared

Financial-Based Measures	Activity-Based Measures
1. Organizational unit budgets	1. Process-oriented standards
2. Standard costing	2. Value-added standards
3. Static standards	3. Dynamic standards
4. Currently attainable standards	4. Optimal standards

[12] Norman Klein and Robert Kaplan, *Chemical Bank: Implementing the Balanced Scorecard* (Harvard Business School, Case 125–210, 1995): 5–6.

[13] Davenport, *Process Innovation*, 97.

Exhibit 14-11

Performance Evaluation Compared

Financial-Based Performance Evaluation	Activity-Based Performance Evaluation
1. Financial efficiency	1. Time reductions
2. Controllable costs	2. Quality improvements
3. Actual versus standard	3. Cost reductions
4. Financial measures	4. Trend measurement

Evaluating Performance

Exhibit 14-11 compares performance evaluation under financial- and activity-based responsibility accounting systems. In a financial-based framework, performance is measured by comparing actual outcomes with budgeted outcomes. In principle, individuals are held accountable only for those items over which they have control. Financial performance, as measured by the ability to meet or beat a stable financial standard, is strongly emphasized. In the activity-based framework, performance is concerned with more than just the financial perspective. The process perspective adds time, quality, and efficiency as critical dimensions of performance. Decreasing the time a process takes to deliver its output to customers is viewed as a vital objective. Thus, nonfinancial, process-oriented measures such as cycle-time and on-time deliveries become important. Performance is evaluated by gauging whether these measures are improving over time. The same is true for measures relating to quality and efficiency. Improving a process should translate into better financial results. Hence, measures of cost reductions achieved, trends in cost, and cost per unit of output are all useful indicators of whether a process has improved. Progress toward achieving optimal standards and interim standards needs to be measured. The objective is to provide low-cost, high-quality products, delivered on a timely basis.

Assigning Rewards

In both systems, individuals are rewarded or penalized according to the policies and discretion of higher management. As Exhibit 14-12 shows, many of the same financial instruments (e.g., salary increases, bonuses, profit sharing, and promotions) are used to provide rewards for good performance. Of course, the nature of the incentive structure differs in each system. For example, the reward system in a financial-based responsibility accounting system is designed to encourage individuals to achieve or beat budgetary standards. Furthermore, for the activity-based responsibility system, rewarding individuals is more complicated than it is in a unit-based setting. Individuals simultaneously have accountability for team and individual performance. Since process-related improvements are mostly achieved through team

Exhibit 14-12

Rewards Compared

Financial-Based Rewards	Activity-Based Rewards
1. Financial performance basis	1. Multidimensional performance basis
2. Individual rewards	2. Group rewards
3. Salary increases	3. Salary increases
4. Promotions	4. Promotions
5. Bonuses and profit sharing	5. Bonuses, profit sharing, and gainsharing

efforts, group-based rewards are more suitable than individual rewards. In one company (a producer of electronic components), for example, optimal standards have been set for unit costs, on-time delivery, quality, inventory turns, scrap, and cycle time.[14] Bonuses are awarded to the team whenever performance is maintained on all measures and improves on at least one measure. Notice the multidimensional nature of this measurement and reward system. Another difference concerns the notion of gainsharing versus profit sharing. Profit sharing is a global incentive designed to encourage employees to contribute to the overall financial well-being of the organization. Gainsharing is more specific. Employees are allowed to share in gains related to specific improvement projects. Gainsharing helps obtain the necessary buy-in for specific improvement projects inherent to activity-based management.

Summary of Learning Objectives

1. Describe how activity-based management and activity-based costing differ.

- Activity-based management encompasses both activity-based costing and process value analysis.
- Activity-based costing is concerned with accurate assignment of costs to cost objects and is an important source of information for managing activities. ABC, however, is not concerned with the issue or presence of waste in activities.
- Identifying waste and its causes and eliminating it fall within the domain of process value analysis.

2. Define process value analysis.

- Process value analysis emphasizes activity management with the intent of maximizing systemwide performance. It consists of three elements: driver analysis, activity analysis, and performance measurement.
- Driver analysis is also referred to as root cause analysis. It seeks to identify why activities are performed.
- Activity analysis identifies all activities and the resources they consume and classifies activities as value-added or non-value-added.
- Performance measurement is concerned with how well activities are performed.

3. Describe activity-based financial performance measurement.

- Reporting value- and non-value-added costs is an integral part of a sound activity-based management system. Tracking trends in these costs over time is an effective control measure.
- Once management determines the source of non-value-added costs, a focused program of continuous improvement can be implemented.
- Kaizen costing is a well-accepted approach for reducing costs by eliminating waste.
- Activity flexible budgeting and activity capacity management offer additional control capabilities.
- Activity flexible budgeting differs from the traditional approach by using more than unit-level drivers to predict what costs will be at different levels of activity output.
- Activity capacity management involves identification of the volume variance (non-value-added cost) and the unused capacity variance (progress toward reducing non-value-added cost).

[14] C. J. McNair, "Responsibility Accounting and Controllability Networks," *Handbook of Cost Management* (Boston: Warren Gorham Lamont, 1993): E41–E43.

4. Discuss the implementation issues associated with an activity-based management system.

- Implementing an activity-based management system requires careful planning and execution.
- The objectives of the system must be identified and explained.
- The benefits of the system and the anticipated effects should also be noted.
- A key issue is assessing and managing the ability of the organization to implement, learn, and use the new activity information. Strong support from higher management is critical for this process.

5. Explain how activity-based management is a form of responsibility accounting, and tell how it differs from financial-based responsibility accounting.

- A firm can adopt one of three responsibility accounting systems.
- Two are discussed in this chapter: financial-based responsibility accounting and activity-based responsibility accounting.
- Financial-based responsibility accounting focuses on organizational units such as departments and plants; uses financial outcome measures, static standards, and benchmarks to evaluate performance; and emphasizes status quo and organizational stability.
- Activity-based responsibility accounting focuses on processes, uses both operational and financial measures, employs dynamic standards, and emphasizes and supports continuous improvement.

CORNERSTONES FOR CHAPTER 14

Review Problems

I. Financial-Based Responsibility Accounting versus Activity-Based Responsibility Accounting

The labour standard for a company is two hours per unit produced, which includes setup time. At the beginning of the last quarter, 20,000 units had been produced and 44,000 hours used. The production manager was concerned about the prospect of reporting an unfavourable labour efficiency variance at the end of the year. Any unfavourable variance over 9 to 10 percent of the standard usually meant a negative performance rating. Bonuses were adversely affected by negative ratings. Accordingly, for the last quarter, the production manager decided to reduce the number of setups and use longer production runs. He knew that his production workers usually were within 5 percent of the standard. The real problem was with setup times. By reducing the setups, the actual hours used would be within 7 to 8 percent of the standard hours allowed.

Required:

1. Explain why the behaviour of the production manager is unacceptable for a continuous improvement environment.
2. Explain how an activity-based responsibility accounting approach would discourage the kind of behaviour described.

Solution:

1. In a continuous improvement environment, efforts are made to reduce inventories and eliminate non-value-added costs. The production manager is focusing on meeting the labour usage standard and is ignoring the impact on inventories that longer production runs may have.
2. Activity-based responsibility accounting focuses on activities and activity performance. For the setup activity, the value-added standard would be zero setup time and zero setup costs. Thus, avoiding setups would neither save labour time nor affect the labour variance. Of course, labour variances themselves would not be computed—at least not at the operational level.

II. Activity Volume Variance, Unused Activity Capacity, Value- and Non-Value-Added Cost Reports, Kaizen Standards

Pollard Manufacturing has developed value-added standards for its activities including material usage, purchasing, and inspecting. The value-added output levels for each of the activities, their actual levels achieved, and the standard prices are as follows:

Activity	Activity Driver	*SQ*	*AQ*	*SP*
Using lumber	Board feet	24,000	30,000	$10
Purchasing	Purchase orders	800	1,000	50
Inspecting	Inspection hours	0	4,000	12

Assume that material usage and purchasing costs correspond to flexible resources (acquired as needed) and that inspection uses resources that are acquired in blocks or steps of 2,000 hours. The actual prices paid for the inputs equal the standard prices.

Required:

1. Assume that continuous improvement efforts reduce the demand for inspection by 30 percent during the year (actual activity usage drops by 30 percent). Calculate the volume and unused capacity variances for the inspection activity. Explain their meaning. Also, explain why there is no volume or unused capacity variance for the other two activities.
2. Prepare a cost report that details value- and non-value-added costs.
3. Suppose that the company wants to reduce all non-value-added costs by 30 percent in the coming year. Prepare kaizen standards that can be used to evaluate the company's progress toward this goal. How much will these measures save in resource spending?

Solution:

1.

$SP \times SQ$	$SP \times AQ$	$SP \times AU$
$12 × 0	$12 × 4,000	$12 × 2,800
$0	$48,000	$33,600
	Volume Variance $48,000 U	Unused Capacity Variance $14,400 F

The activity volume variance is the non-value-added cost. The unused capacity variance measures the cost of the unused activity capacity. The other two activities have no volume variance or capacity variance because they use only flexible resources. No activity capacity is acquired in advance of usage; thus, there cannot be an unused capacity variance or a volume variance.

2.

	Costs		
	Value-Added	Non-Value-Added	Total
Using lumber	$240,000	$ 60,000	$300,000
Purchasing	40,000	10,000	50,000
Inspecting	0	48,000	48,000
Total	$280,000	$118,000	$398,000

3.

	Kaizen Standards	
	Quantity	Cost
Using lumber	28,200	$282,000
Purchasing	940	47,000
Inspecting	2,800	33,600

If the standards are met, then the savings are as follows:

Using lumber: $10 × 1,800	=	$18,000
Purchasing: $50 × 60	=	3,000
Savings		$21,000

There is no reduction in resource spending for inspecting because it must be purchased in increments of 2,000 and only 1,200 hours were saved—another 800 hours must be reduced before any reduction in resource spending is possible. The unused capacity variance must reach $24,000 before resource spending can be reduced.

Key Terms

Activity analysis, 704
Activity capacity, 717
Activity elimination, 707
Activity flexible budgeting, 715
Activity output measure, 704
Activity reduction, 707
Activity selection, 707
Activity sharing, 707
Activity volume variance, 717
Activity-based management (ABM), 703
Activity-based responsibility accounting, 723
Benchmarking, 713
Continuous improvement, 702
Driver analysis, 704
Financial measures, 708
Financial-based responsibility accounting system, 723
Kaizen costing, 707
Kaizen standard, 712
Non-value-added activities, 705
Non-value-added costs, 706
Process creation, 725
Process improvement, 724
Process innovation (business re-engineering), 724
Process value analysis (PVA), 704
Responsibility accounting, 723
Unused capacity variance, 717
Value-added activities, 705
Value-added costs, 705
Value-added standard, 708

Discussion Questions

1. What are the two dimensions of the activity-based management model? How do they differ?
2. What is driver analysis? What role does it play in process value analysis?
3. What is activity analysis? Why is this approach compatible with the goal of continuous improvement?
4. What are value-added activities? Value-added costs?
5. What are non-value-added activities? Non-value-added costs? Give an example of each.
6. Identify and define four different ways to manage activities so that costs can be reduced.
7. What is a kaizen standard? Describe the kaizen and maintenance subcycles.
8. Explain how benchmarking can be used to improve activity performance.
9. Explain how activity flexible budgeting differs from unit-based flexible budgeting.

10. In implementing an ABM system, what are some of the planning considerations?
11. Explain why a detailed task description is needed for ABM and not for ABC.
12. What are some of the reasons that ABM implementation may lose the support of higher management?
13. Explain how lack of integration of an ABM system may cause its failure.
14. Describe a financial-based responsibility accounting system.
15. Describe an activity-based responsibility accounting system. How does it differ from financial-based responsibility accounting?

Cornerstone Exercises

Cornerstone Exercise 14-1 VALUE- AND NON-VALUE-ADDED COST REPORTING

OBJECTIVE 3
CORNERSTONE 14-1
SERVICE

Espera Distribution Centre has four activities: receiving materials, assembly, expediting products, and storing goods. Receiving and assembly are necessary activities; expediting and storing goods are unnecessary. The following data pertain to the four activities for the year ending 2012 (actual price per unit of the activity driver is assumed to be equal to the standard price):

Activity	Activity Driver	*SQ*	*AQ*	*SP*
Receiving	Receiving orders	8,000	12,000	$21
Assembly	Labour hours	50,000	60,000	15
Expediting	Orders expedited	0	4,000	50
Storing	Number of units	0	8,000	7

Required:

1. Prepare a cost report for the year ending 2012 that shows value-added costs, non-value-added costs, and total costs for each activity.
2. Explain why expediting products and storing goods are non-value-added activities.
3. ***What if*** receiving cost is a step-fixed cost with each step being 1,000 orders whereas assembly cost is a variable cost? What is the implication for reducing the cost of waste for each activity?

Cornerstone Exercise 14-2 TREND REPORTING FOR NON-VALUE-ADDED COSTS

OBJECTIVE 3
CORNERSTONE 14-2
SERVICE

Refer to **Cornerstone Exercise 14-1**. Assume that at the beginning of 2013, Espera trained the assembly workers in a new approach that had the objective of increasing the efficiency of the assembly process. Espera also began moving toward a JIT purchasing system. When JIT is fully implemented, the demand for expediting is expected to be virtually eliminated. It is expected to take two to three years for full implementation. Assume that receiving cost is a step-fixed cost with steps of 1,000 orders. The other three activities employ resources that are acquired as used and needed. At the end of 2013, the following results were reported for the four activities:

Activity	Activity Driver	*SQ*	*AQ*	*SP*
Receiving	Receiving orders	8,000	8,000	$21
Assembly	Labour hours	50,000	52,000	15
Expediting	Orders expedited	0	2,000	50
Storing	Number of units	0	4,000	7

Required:

1. Prepare a trend report that shows the non-value-added costs for each activity for 2012 and 2013 and the change in costs for the two periods. Discuss the report's implications.
2. Explain the role of activity reduction for receiving and for expediting. What is the expected value of *SQ* for each activity after JIT is fully implemented?

3. ***What if*** at the end of 2013, the selling price of a competing product is reduced by $18 per unit? Assume that the firm produces and sells 20,000 units of its product and that its product is associated only with the four activities being considered. By virtue of the waste-reduction savings, can the competitor's price reduction be matched without reducing the unit profit margin of the product that prevailed at the beginning of the year? If not, how much more waste reduction is needed to achieve this outcome? In this case, what price decision would you recommend?

OBJECTIVE 3

CORNERSTONE 14-3

Cornerstone Exercise 14-3 KAIZEN COSTING

Lansky Inc. produces custom-made machine parts. A setup activity is required for the batches of parts that it produces. Activity output is measured using setup hours. The value-added standard (*SQ*) for this activity is zero. On July 1, at the beginning of the fiscal year, five setup hours were allowed and used per batch. The standard wage rate for setup labour is $15 per setup hour. During the first quarter of the new fiscal year, the company is planning to implement a new setup method developed by Lansky's industrial engineers that is expected to reduce setup time by 40 percent. The new procedure was implemented during the first quarter and the improvement expected was realized.

Required:

1. What is the setup standard for setup hours and the associated expected cost at the beginning of the first quarter? The kaizen standard and expected associated cost?
2. What is the setup standard for setup hours and the associated cost at the end of the first quarter? Explain. What is the next step in the kaizen cost reduction process?
3. ***What if*** the new procedure implemented in the first quarter only produced a 30 percent reduction in setup time instead of the expected 40 percent reduction? What would the new maintenance standard and cost be? What criteria would you logically expect to be met before maintenance standards and costs are modified?

OBJECTIVE 3

CORNERSTONE 14-4

SERVICE

Cornerstone Exercise 14-4 ACTIVITY-BASED FLEXIBLE BUDGETING

Balzac Company sells iron railings for indoor and outdoor use. In order to assemble the railings to custom size, Balzac welds them together. Balzac wants to develop a flexible budget formula for the welding. The following resources are used by the activity:

- Four welding units, with a lease cost of $12,000 per year per unit
- Six welding employees each paid a salary of $50,000 per year (A total of 9,000 welding hours are supplied by the six workers.)
- Welding supplies: $300 per job
- Welding hours: Three hours used per job

During the year, the activity operated at 90 percent of capacity and incurred the following actual activity and resource costs:

- Lease cost: $48,000
- Salaries: $315,000
- Parts and supplies: $805,000

Required:

1. Prepare a flexible budget formula for the welding activity using welding hours as the driver.
2. Prepare a performance report for the welding activity.
3. ***What if*** welders were hired through outsourcing and paid $30 per hour (the welding equipment is provided by Balzac)? Repeat Requirement 1 for the outsourcing case.

OBJECTIVE 3

CORNERSTONE 14-5

Cornerstone Exercise 14-5 ACTIVITY CAPACITY MANAGEMENT

Uchdorf Manufacturing just completed a study of its purchasing activity with the objective of improving its efficiency. The driver for the activity is number of purchase orders. The following data pertain to the activity for the most recent year:

Activity supply: five purchasing agents capable of processing 2,400 orders per year (12,000 orders)
Purchasing agent cost (salary): $45,600 per year
Actual usage: 10,600 orders per year
Value-added quantity: 7,000 orders per year

Required:

1. Calculate the volume variance and explain its significance.
2. Calculate the unused capacity variance and explain its use.
3. ***What if*** the actual usage drops to 9,000 orders? What effect will this have on capacity management? What will be the level of spending reduction if the value-added standard is met?

Exercises

Exercise 14-6 ABC VERSUS ABM

OBJECTIVE 1 2

Fresco Inc. produces elite juicers (priced at $300) as well as supreme juicers (priced at $180). Recently, Fresco has been losing market share with its supreme juicers because of competitors offering juicers with the same quality and features but at a lower price. A careful market study revealed that if Fresco could reduce the price of its supreme juicer to $170, it would regain its former share of the market. Management, however, is convinced that any price reduction must be accompanied by a cost reduction of the same amount so that per-unit profitability is not affected. Charles McManus, company controller, has indicated that poor overhead costing assignments may be distorting management's view of each product's cost and, therefore, the ability to know how to set selling prices. Charles has identified the following overhead activities: assembly, inspection, and rework. The three activities, their costs, and practical capacities are as follows:

Activity	Cost	Practical Capacity
Assembly	$2,700,000	90,000 assembly hours
Inspection	1,800,000	45,000 inspection hours
Rework	900,000	45,000 rework hours

The consumption patterns of the two products are as follows:

	Supreme	Elite
Units	100,000	30,000
Assembly hours	50,000	40,000
Inspection hours	10,000	35,000
Rework hours	7,500	37,500

Fresco assigns overhead costs to the two products using a plantwide rate based on direct labour (assembly) hours.

Required:

1. Calculate the unit overhead cost of the supreme juicer using assembly hours to assign overhead costs. Now, repeat the calculation using ABC to assign overhead costs. Did improving the accuracy of cost assignments solve Fresco's competitive problem? What did it reveal?
2. Now, assume that *in addition* to improving the accuracy of cost assignments, Charles observes that defective supplier components are the root cause of both the inspection and rework activities. Suppose further that Fresco has found a new supplier that provides higher-quality components such that inspection and rework costs are reduced by 50 percent. Now, calculate the cost of each product (assuming that inspection and rework time are also reduced by 50 percent) using ABC. The relative consumption patterns also remain the same. Comment on the difference between ABC and ABM.

OBJECTIVE 2

Exercise 14-7 ROOT CAUSE (DRIVER ANALYSIS)

For the following two activities, ask a series of "why" questions (with your answers) that reveal the root cause. Once the root cause is identified, use a "how" question to reveal how the activity can be improved (with your answer).

Activity 1: Daily cleaning of a puddle of oil near production machinery.
Activity 2: Providing customers with sales allowances.

OBJECTIVE 2

SERVICE

Exercise 14-8 NON-VALUE-ADDED ACTIVITIES: NON-VALUE-ADDED COST

Epsilon Company has 20 clerks who work in its Accounts Payable Department. A study revealed the following activities and the relative time demanded by each activity:

Activities	Percentage of Clerical Time
Comparing purchase orders and receiving orders and invoices	15%
Resolving discrepancies among the three documents	70
Preparing cheques for suppliers	10
Making journal entries and mailing cheques	5

The average salary of a clerk is $30,000.

Required:

Classify the four activities as value-added or non-value-added, and calculate the clerical cost of each activity. For non-value-added activities, indicate why they are non-value-added.

OBJECTIVE 2

SERVICE

Exercise 14-9 ROOT CAUSE (DRIVER ANALYSIS)

Refer to **Exercise 14-8.**

Required:

Suppose that clerical error—either Epsilon's or the supplier's—is the common root cause of the non-value-added activities. For each non-value-added activity, ask a series of "why" questions that identify clerical error as the activity's root cause.

OBJECTIVE 2 5

SERVICE

Exercise 14-10 PROCESS IMPROVEMENT/INNOVATION

Refer to **Exercise 14-8**. Suppose that clerical error is the common root cause of the non-value-added activities. Paying bills is a subprocess that belongs to the procurement process. The procurement process is made up of three subprocesses: purchasing, receiving, and paying bills.

Required:

1. What is the definition of a process? Identify the common objective for the procurement process. Repeat for each subprocess.
2. Now, suppose that Epsilon decides to attack the root cause of the non-value-added activities of the bill-paying process by improving the skills of its purchasing and receiving clerks. As a result, the number of discrepancies found drops by 30 percent. Discuss the potential effect this initiative might have on the bill-paying process. Does this initiative represent process improvement or process innovation? Explain.

OBJECTIVE 2 5

SERVICE

Exercise 14-11 PROCESS IMPROVEMENT/INNOVATION

Refer to **Exercise 14-10.** Suppose that Epsilon attacks the root cause of the non-value-added activities by establishing a totally different approach to procurement called electronic data interchange (EDI). EDI gives suppliers access to Epsilon's online database that reveals Epsilon's production schedule. By knowing Epsilon's production schedule, suppliers can deliver the parts and supplies needed just in time for their use. When the parts are shipped, an electronic message is sent from the supplier to Epsilon that the shipment is en route. When the order arrives, a bar code is scanned with an electronic wand initiating payment for the goods. EDI involves no paper—no purchase orders—no receiving orders—and no invoices.

Required:

Discuss the potential effects of this solution on Epsilon's bill-paying process. Is this process innovation or process improvement? Explain.

Exercise 14-12 VALUE- AND NON-VALUE-ADDED COSTS, UNUSED CAPACITY

OBJECTIVE 2 3

For Situations 1 through 6, provide the following information:

a. An estimate of the non-value-added cost caused by each activity.
b. The root causes of the activity cost (such as plant layout, process design, and product design).
c. The appropriate cost reduction measure: activity elimination, activity reduction, activity sharing, or activity selection.

1. It takes 45 minutes and six kilograms of material to produce a product using a traditional manufacturing process. A process re-engineering study provided a new manufacturing process design (using existing technology) that would take 15 minutes and four kilograms of material. The cost per labour hour is $12, and the cost per kilogram of material is $8.
2. With its original design, a product requires 15 hours of setup time. Redesigning the product could reduce the setup time to an absolute minimum of 30 minutes. The cost per hour of setup time is $200.
3. A product currently requires eight moves. By redesigning the manufacturing layout, the number of moves can be reduced from eight to zero. The cost per move is $10.
4. Inspection time for a plant is 8,000 hours per year. The cost of inspection consists of salaries of four inspectors, totalling $120,000. Inspection also uses supplies costing $2 per inspection hour. A supplier evaluation program, product redesign, and process redesign reduced the need for inspection by creating a zero-defect environment.
5. Each unit of a product requires five components. The average number of components is 5.3 due to component failure, requiring rework and extra components. By developing relations with the right suppliers and increasing the quality of the purchased component, the average number of components can be reduced to five components per unit. The cost per component is $600.
6. A plant produces 100 different electronic products. Each product requires an average of eight components that are purchased externally. The components are different for each part. By redesigning the products, it is possible to produce the 100 products so that they all have four components in common. This will reduce the demand for purchasing, receiving, and paying bills. Estimated savings from the reduced demand are $900,000 per year.

Exercise 14-13 CALCULATION OF VALUE- AND NON-VALUE-ADDED COSTS, ACTIVITY VOLUME AND UNUSED CAPACITY VARIANCES

OBJECTIVE 2 3 4

Maquina Company produces custom-made machine parts. Maquina recently has implemented an activity-based management (ABM) system with the objective of reducing costs. Maquina has begun analyzing each activity to determine ways to increase its efficiency. Setting up equipment was among the first group of activities to be carefully studied. The study revealed that setup hours was a good driver for the activity. During the last year, the company incurred fixed setup costs of $504,000 (salaries of 14 employees). The fixed costs provide a capacity of 28,000 hours (2,000 per employee at practical capacity). The setup activity was viewed as necessary, and the value-added standard was set at 2,000 hours. Actual setup hours used in the most recent period were 26,200.

Required:

1. Calculate the volume and unused capacity variances for the setup activity. Explain what each variance means.
2. Prepare a report that presents value-added, non-value-added, and actual costs for setup. Explain why highlighting the non-value-added costs is important.

3. Assume that management is able to reduce the demand for the setup activity so that the actual hours needed drop from 26,200 to 4,000. What actions should now be taken regarding activity capacity management?
4. Another activity studied was inspection of supplier materials/components. Explain why inspecting incoming goods should be viewed as a non-value-added activity. In providing your explanation, consider the following counterargument: "Inspecting incoming goods adds value because it reduces the demand for other unnecessary activities such as rework, reordering, and warranty work."

OBJECTIVE 2 3

Exercise 14-14 COST REPORT, VALUE-ADDED AND NON-VALUE-ADDED COSTS

SERVICE

Vecchio Company has developed value-added standards for four activities: purchasing parts, receiving parts, moving parts, and setting up equipment. The activities, the activity drivers, the standard and actual quantities, and the price standards for 2012 are as follows:

Activities	Activity Driver	SQ	AQ	SP
Purchasing parts	Purchase orders	1,300	1,820	$200
Receiving parts	Receiving orders	2,600	3,900	130
Moving parts	Number of moves	0	1,300	260
Setting up equipment	Setup hours	0	5,200	78

The actual prices paid per unit of each activity driver were equal to the standard prices.

Required:

1. Prepare a cost report that lists the value-added, non-value-added, and actual costs for each activity.
2. Which activities are non-value-added? Explain why. Also, explain why value-added activities can have non-value-added costs.

OBJECTIVE 2 3

Exercise 14-15 TREND REPORT, NON-VALUE-ADDED COSTS

SERVICE

Refer to **Exercise 14-14.** Suppose that for 2013, Vecchio Company has chosen suppliers that provide higher-quality parts and redesigned its plant layout to reduce material movement. Additionally, Vecchio implemented a new setup procedure and provided training for its purchasing agents. As a consequence, less setup time is required and fewer purchasing mistakes are made. At the end of 2013, the following information is provided:

Activities	Activity Driver	SQ	AQ	SP
Purchasing parts	Purchase orders	1,300	1,560	$200
Receiving parts	Receiving orders	3,380	4,056	130
Moving parts	Number of moves	0	420	260
Setting up equipment	Setup hours	0	1,300	78

Required:

1. Prepare a report that compares the non-value-added costs for 2013 with those of 2012.
2. What is the role of activity reduction for non-value-added activities? For value-added activities?
3. Comment on the value of a trend report.

OBJECTIVE 4

Exercise 14-16 IMPLEMENTATION OF ACTIVITY-BASED MANAGEMENT

Asma Haji, manager of an electronics division, was not pleased with the results that had recently been reported concerning the division's activity-based management implementation project. For one thing, the project had taken eight months longer than projected and had exceeded the budget by nearly 35 percent. But even more vexatious was the fact that after all was said and done, about three-fourths of the plants were reporting that the activity-based product costs were not much different for most of the products than those of the old costing system. Plant managers were indicating that they were continuing to use the old costs as they were easier to compute and understand. Yet, at the same time,

they were complaining that they were having a hard time meeting the bids of competitors. Reliable sources were also revealing that the division's product costs were higher than many competitors'. This outcome perplexed plant managers because their control system continued to report favourable materials and labour efficiency variances. They complained that ABM had failed to produce any significant improvement in cost performance.

Asma decided to tour several of the plants and talk with the plant managers. After the tour, she realized that her managers did not understand the concept of non-value-added costs nor did they have a good grasp of the concept of kaizen costing. No efforts were being made to carefully consider the activity information that had been produced. One typical plant manager threw up his hands and said: "This is too much data. Why should I care about all this detail? I do not see how this can help me improve my plant's performance. They tell me that inspection is not a necessary activity and does not add value. I simply can't believe that inspecting isn't value-added and necessary. If we did not inspect, we would be making and sending more bad products to customers."

Required:

Explain why Asma's division is having problems with its ABM implementation.

Exercise 14-17 FINANCIAL-BASED VERSUS ACTIVITY-BASED RESPONSIBILITY ACCOUNTING

OBJECTIVE 5

For each of the following situations, two scenarios are described, labelled A and B. Choose which scenario is descriptive of a setting corresponding to activity-based responsibility accounting and which is descriptive of financial-based responsibility accounting. Provide a brief commentary on the differences between the two systems for each situation, addressing the possible advantages of the activity-based view over the financial-based view.

Situation 1

A: The purchasing manager, receiving manager, and accounts payable manager are given joint responsibility for procurement. The instructions given to the group of managers are to reduce costs of acquiring materials, decrease the time required to obtain materials from outside suppliers, and reduce the number of purchasing mistakes (e.g., wrong type of materials or the wrong quantities ordered).

B: The plant manager commended the manager of the Grinding Department for increasing his department's machine utilization rates—and doing so without exceeding the department's budget. The plant manager then asked other department managers to make an effort to obtain similar efficiency improvements.

Situation 2

A: Delivery mistakes had been reduced by 70 percent, saving over $40,000 per year. Furthermore, delivery time to customers had been cut by two days. According to company policy, the team responsible for the savings was given a bonus equal to 25 percent of the savings attributable to improving delivery quality. Company policy also provided a salary increase of 1 percent for every day saved in delivery time.

B: Bill Johnson, manager of the Product Development Department, was pleased with his department's performance on the last quarter's projects. They had managed to complete all projects under budget, virtually assuring Bill of a fat bonus, just in time to help with this year's Christmas purchases.

Situation 3

A: "Harvey, don't worry about the fact that your department is producing at only 70 percent capacity. Increasing your output would simply pile up inventory in front of the next production department. That would be costly for the organization as a whole. Sometimes, one department must reduce its performance so that the performance of the entire organization can improve."

B: "Susan, I am concerned about the fact that your department's performance measures have really dropped over the past quarter. Labour usage variances are unfavourable, and I also see that your machine utilization rates are down. Now, I know you are not a bottleneck department, but I get a lot of flack when my managers' efficiency ratings drop."

Situation 4

A: Vasily was muttering to himself. He had just received last quarter's budgetary performance report. Once again, he had managed to spend more than budgeted for both materials and labour. The real question now was how to improve his performance for the next quarter.

B: Great! Cycle time had been reduced and, at the same time, the number of defective products had been cut by 35 percent. Cutting the number of defects reduced production costs by more than planned. Trends were favourable for all three performance measures.

Situation 5

A: Cambry was furious. An across-the-board budget cut! "How can they expect me to provide the computer services required on less money? Management is convinced that costs are out of control, but I would like to know where—at least in my department!"

B: After a careful study of the Accounts Payable Department, it was discovered that 80 percent of an accounts payable clerk's time was spent resolving discrepancies between the purchase order, the receiving document, and the supplier's invoice. Other activities such as recording and preparing cheques consumed only 20 percent of a clerk's time. A redesign of the procurement process eliminated virtually all discrepancies and produced significant cost savings.

Situation 6

A: Five years ago, the management of Breeann Products commissioned an outside engineering consulting firm to conduct a time-and-motion study so that labour efficiency standards could be developed and used in production. These labour efficiency standards are still in use today and are viewed by management as an important indicator of productive efficiency.

B: Janet was quite satisfied with this quarter's labour performance. When compared with the same quarter of last year, labour productivity had increased by 23 percent. Most of the increase was due to a new assembly approach suggested by production line workers. She was also pleased to see that materials productivity had increased. The increase in materials productivity was attributed to reducing scrap because of improved quality.

Situation 7

A: "The system converts materials into products, not people at work stations. Therefore, process efficiency is more important than labour efficiency—but we also must pay particular attention to those who use the products we produce, whether inside or outside the firm."

B: "I was quite happy to see a revenue increase of 15 percent over last year, especially when the budget called for a 10 percent increase. However, after reading the recent copy of our trade journal, I now wonder whether we are doing so well. I found out that the market expanded by 30 percent, and our leading competitor increased its sales by 40 percent."

Problems

OBJECTIVE ➤ 1 2 4

Problem 14-18 ABM IMPLEMENTATION, ACTIVITY ANALYSIS, ACTIVITY DRIVERS, DRIVER ANALYSIS, BEHAVIOURAL EFFECTS

Joseph Lee, controller of Thorpe Company, has been in charge of a project to install an activity-based cost management system. This new system is designed to support the

company's efforts to become more competitive. For the past six weeks, he and the project committee members have been identifying and defining activities, associating workers with activities, and assessing the time and resources consumed by individual activities. Now, he and the project committee are focusing on three additional implementation issues: (1) identifying activity drivers, (2) assessing value content, and (3) identifying cost drivers (root causes). Joseph has assigned a committee member the responsibilities of assessing the value content of five activities, choosing a suitable activity driver for each activity, and identifying the possible root causes of the activities. Following are the five activities with possible activity drivers:

Activity	Possible Activity Drivers
Setting up equipment	Setup time, number of setups
Performing warranty work	Warranty hours, number of defective units
Welding subassemblies	Welding hours, subassemblies welded
Moving materials	Number of moves, distance moved
Inspecting components	Hours of inspection, number of defective components

The committee member ran a regression analysis for each potential activity driver, using the method of least squares to estimate the variable and fixed cost components. In all five cases, costs were highly correlated with the potential drivers. Thus, all drivers appeared to be good candidates for assigning costs to products. The company plans to reward production managers for reducing product costs.

Required:

1. What is the difference between an activity driver and a cost driver? In answering the question, describe the purpose of each type of driver.
2. For each activity, assess the value content and classify each activity as value-added or non-value-added (justify the classification). Identify some possible root causes of each activity, and describe how this knowledge can be used to improve activity performance. For purposes of discussion, assume that the value-added activities are not performed with perfect efficiency.
3. Describe the behaviour that each activity driver will encourage, and evaluate the suitability of that behaviour for the company's objective of becoming more competitive.

Problem 14-19 ABM, KAIZEN COSTING

OBJECTIVE 2 3 5

Cycleta Inc. supplies small motors for a large appliance manufacturing company. The appliance company has recently requested that Cycleta decrease its delivery time. Cycleta made a commitment to reduce the lead time for delivery from seven days to one day. To help achieve this goal, engineering and production workers had made the commitment to reduce time for the setup activity (other activities such as moving materials and rework were also being examined simultaneously). Current setup times were 18 hours. Setup cost was $400 per setup hour. For the first quarter, engineering developed a new process design that it believed would reduce the setup time from 18 hours to nine hours. After implementing the design, the actual setup time dropped from 18 hours to eight hours. Engineering believed the actual reduction was sustainable. In the second quarter, production workers suggested a new setup procedure. Engineering gave the suggestion a positive evaluation, and they projected that the new approach would save an additional six hours of setup time. Setup labour was trained to perform the new setup procedures. The actual reduction in setup time based on the suggested changes was five hours.

Required:

1. What kaizen setup standard would be used at the beginning of each quarter?
2. Describe the kaizen subcycle using the two quarters of data provided by Cycleta.
3. Describe the setup subcycle using the two quarters of data provided by Cycleta.
4. How much non-value-added cost was eliminated by the end of two quarters? Discuss the role of kaizen costing in activity-based management.
5. Explain why kaizen costing is compatible with activity-based responsibility accounting while standard costing is compatible with financial-based responsibility accounting.

OBJECTIVE 3

Problem 14-20 ACTIVITY FLEXIBLE BUDGETING, PERFORMANCE REPORT, VOLUME VARIANCE

Innovator Inc. wants to develop an activity flexible budget for the activity of moving materials. Innovator uses eight forklifts to move materials from receiving to stores. The forklifts are also used to move materials from stores to the production area. The forklifts are obtained through an operating lease that costs $12,000 per year per forklift. Innovator employs 25 forklift operators who receive an average salary of $45,000 per year, including benefits. Each move requires the use of a crate. The crates are used to store the parts and are emptied only when used in production. Crates are disposed of after one cycle (two moves), where a cycle is defined as a move from receiving to stores to production. Each crate costs $1.20. Special fuel for a forklift costs $1.80 per litre. A litre of fuel is used every 20 moves. Forklifts can make three moves per hour and are available for 280 days per year, 24 hours per day (the remaining time is downtime for various reasons). Each operator works 40 hours per week and 50 weeks per year.

Required:

1. Prepare a flexible budget for the activity of moving materials, using the number of cycles as the activity driver.
2. Calculate the activity capacity for moving materials. Suppose Innovator works at 90 percent of activity capacity and incurs the following costs:

Salaries	$1,170,000
Leases	96,000
Crates	91,200
Fuel	14,450

   Prepare the budget for the 90 percent level and then prepare a performance report for the moving materials activity.
3. Calculate and interpret the volume variance for moving materials.
4. Suppose that a redesign of the plant layout reduces the demand for moving materials to one-third of the original capacity. What would be the budget formula for this new activity level? What is the budgeted cost for this new activity level? Has activity performance improved? How does this activity performance evaluation differ from that described in Requirement 2? Explain.

OBJECTIVE 2 3

Problem 14-21 ACTIVITY-BASED MANAGEMENT, NON-VALUE-ADDED COSTS, TARGET COSTS, KAIZEN COSTING

Hassan Khalil, president of Harmony Electronics, was concerned about the end-of-the-year marketing report that he had just received. According to Emily Hagood, marketing manager, a price decrease for the coming year was again needed to maintain the company's annual sales volume of integrated circuit boards (CBs). This would make a bad situation worse. The current selling price of $18 per unit was producing a $2-per-unit profit—half the customary $4-per-unit profit. Foreign competitors keep reducing their prices. To match the latest reduction would reduce the price from $18 to $14. This would put the price below the cost to produce and sell it. How could the foreign firms sell for such a low price? Determined to find out if there were problems with the company's operations, Hassan decided to hire Jan Booth, a well-known consultant who specializes in methods of continuous improvement. Jan indicated that she felt that an activity-based management system needed to be implemented. After three weeks, Jan had identified the following activities and costs:

Batch-level activities:	
Setting up equipment	$ 125,000
Materials handling	180,000
Inspecting products	122,000
Product-sustaining activities:	
Engineering support	120,000
Handling customer complaints	100,000

Filling warranties	$ 170,000
Storing goods	80,000
Expediting goods	75,000
Unit-level activities:	
Using materials	500,000
Using power	48,000
Manual insertion labour[a]	250,000
Other direct labour	150,000
Total costs	$1,920,000[b]

[a]Diodes, resistors, and integrated circuits are inserted manually into the circuit board.
[b]This total cost produces a unit cost of $16 for last year's sales volume.

Jan indicated that some preliminary activity analysis showed that per-unit costs could be reduced by at least $7. Since Emily had indicated that the market share (sales volume) for the boards could be increased by 50 percent if the price could be reduced to $12, Hassan became quite excited.

Required:

1. What is activity-based management? What connection does it have to continuous improvement?
2. Identify as many non-value-added costs as possible. Compute the cost savings per unit that would be realized if these costs were eliminated. Was Jan correct in her preliminary cost reduction assessment? Discuss actions that the company can take to reduce or eliminate the non-value-added activities.
3. Compute the target cost required to maintain current market share, while earning a profit of $4 per unit. Now, compute the target cost required to expand sales by 50 percent. How much cost reduction would be required to achieve each target?
4. Assume that Jan suggested that kaizen costing be used to help reduce costs. The first suggested kaizen initiative is described by the following: switching to automated insertion would save $60,000 of engineering support and $90,000 of direct labour. Now, what is the total potential cost reduction per unit available? With these additional reductions, can Harmony achieve the target cost to maintain current sales? To increase it by 50 percent? What form of activity analysis is this kaizen initiative: reduction, sharing, elimination, or selection?
5. Calculate income based on current sales, prices, and costs. Now, calculate the income using a $14 price and a $12 price, assuming that the maximum cost reduction possible is achieved (including Requirement 4's kaizen reduction). What price should be selected?

Problem 14-22 VALUE-ADDED AND KAIZEN STANDARDS, NON-VALUE-ADDED COSTS, VOLUME VARIANCE, UNUSED CAPACITY

OBJECTIVE 3

Tom Zhang, vice president of EPIC Company (a producer of plastic products), has been supervising the implementation of an activity-based cost management system. One of Tom's objectives is to improve process efficiency by improving the activities that define the processes. To illustrate the potential of the new system to the president, Tom has decided to focus on two processes: production and customer service.

Within each process, one activity will be selected for improvement: moulding for production and sustaining engineering for customer service. (Sustaining engineers are responsible for redesigning products based on customer needs and feedback.) Value-added standards are identified for each activity. For moulding, the value-added standard calls for nine kilograms per mould. (Although the products differ in shape and function, their size, as measured by weight, is uniform.) The value-added standard is based on the elimination of all waste due to defective moulds (materials is by far the major cost for the moulding activity). The standard price for moulding is $15 per kilogram. For sustaining engineering, the standard is 60 percent of current practical activity capacity. This standard is based on the fact that about 40 percent of the complaints have to do with design features that could have been avoided or anticipated by the company.

Current practical capacity (at the end of 2013) is defined by the following requirements: 18,000 engineering hours for each product group that has been on the market or in development for five years or less, and 7,200 hours per product group of more than five years. Four product groups have less than five years' experience, and 10 product groups have more. There are 72 engineers, each paid a salary of $70,000. Each engineer can provide 2,000 hours of service per year. There are no other significant costs for the engineering activity.

For 2013, actual kilograms used for moulding were 25 percent above the level called for by the value-added standard; engineering usage was 138,000 hours. There were 240,000 units of output produced. Tom and the operational managers have selected some improvement measures that promise to reduce non-value-added activity usage by 30 percent in 2014. Selected actual results achieved for 2014 are as follows:

Units produced	240,000
Kilograms of material	2,600,000
Engineering hours	120,000

The actual prices paid per kilogram and per engineering hour are identical to the standard or budgeted prices.

Required:

1. For 2013, calculate the non-value-added usage and costs for moulding and sustaining engineering. Also, calculate the cost of unused capacity for the engineering activity.
2. Using the targeted reduction, establish kaizen standards for moulding and engineering (for 2014).
3. Using the kaizen standards prepared in Requirement 2, compute the 2014 usage variances, expressed in both physical and financial measures, for moulding and engineering. (For engineering, explain why it is necessary to compare actual resource usage with the kaizen standard.) Comment on the company's ability to achieve its targeted reductions. In particular, discuss what measures the company must take to capture any realized reductions in resource usage.

OBJECTIVE 2 3

Problem 14-23 BENCHMARKING AND NON-VALUE-ADDED COSTS, TARGET COSTING

Bienestar Inc. has two plants that manufacture a line of wheelchairs. One is located in Quebec City and the other in Winnipeg. Each plant is set up as a profit centre. During the past year, both plants sold their tilt wheelchair model for $1,620. Sales volume averages 20,000 units per year in each plant. Recently, the Winnipeg plant reduced the price of the tilt model to $1,440. Discussion with the Winnipeg manager revealed that the price reduction was possible because the plant had reduced its manufacturing and selling costs by reducing what was called "non-value-added costs." The Winnipeg manufacturing and selling costs for the tilt model were $1,260 per unit. The Winnipeg manager offered to loan the Quebec City plant his cost accounting manager to help it achieve similar results. The Quebec City plant manager readily agreed, knowing that his plant must keep pace—not only with the Winnipeg plant but also with competitors. A local competitor had also reduced its price on a similar model, and Quebec City's marketing manager had indicated that the price must be matched or sales would drop dramatically. In fact, the marketing manager suggested that if the price were dropped to $1,404 by the end of the year, the plant could expand its share of the market by 20 percent. The plant manager agreed but insisted that the current profit per unit must be maintained. He also wants to know if the plant can at least match the $1,260 per-unit cost of the Winnipeg plant and if the plant can achieve the cost reduction using the approach of the Winnipeg plant.

The plant controller and the Winnipeg cost accounting manager have assembled the following data for the most recent year. The actual cost of inputs, their value-added (ideal) quantity levels, and the actual quantity levels are provided (for production of 20,000 units). Assume there is no difference between actual prices of activity units and standard prices.

	SQ	AQ	Actual Cost
Materials (kg)	855,000	900,000	$18,900,000
Labour (hrs)	205,200	216,000	2,700,000
Setups (hrs)	—	14,400	1,080,000
Materials handling (moves)	—	36,000	2,520,000
Warranties (no. repaired)	—	36,000	3,600,000
Total			$28,800,000

Required:

1. Calculate the target cost for expanding the Quebec City plant's market share by 20 percent, assuming that the per-unit profitability is maintained as requested by the plant manager.
2. Calculate the non-value-added cost per unit. Assuming that non-value-added costs can be reduced to zero, can the Quebec City plant match the Winnipeg per-unit cost? Can the target cost for expanding market share be achieved? What actions would you take if you were the plant manager?
3. Describe the role benchmarking played in the effort of the Quebec City plant to protect and improve its competitive position.

Problem 14-24 FINANCIAL VERSUS ACTIVITY FLEXIBLE BUDGETING

OBJECTIVE 2 3 5

Kelly Gray, production manager, was upset with the latest performance report, which indicated that she was $100,000 over budget. Given the efforts that she and her workers had made, she was confident that they had met or beat the budget. Now, she was not only upset but also genuinely puzzled over the results. Three items—direct labour, power, and setups—were over budget. The actual costs for these three items follow:

	Actual Costs
Direct labour	$210,000
Power	135,000
Setups	140,000
Total	$485,000

Kelly knew that her operation had produced more units than originally had been budgeted, so more power and labour had naturally been used. She also knew that the uncertainty in scheduling had led to more setups than planned. When she pointed this out to John Huang, the controller, he assured her that the budgeted costs had been adjusted for the increase in productive activity. Curious, Kelly questioned John about the methods used to make the adjustment.

JOHN: If the actual level of activity differs from the original planned level, we adjust the budget by using budget formulas—formulas that allow us to predict what the costs will be for different levels of activity.

KELLY: The approach sounds reasonable. However, I'm sure something is wrong here. Tell me exactly how you adjusted the costs of labour, power, and setups.

JOHN: First, we obtain formulas for the individual items in the budget by using the method of least squares. We assume that cost variations can be explained by variations in productive activity where activity is measured by direct labour hours. Here is a list of the cost formulas for the three items you mentioned. The variable X is the number of direct labour hours:

$$\text{Labour cost} = \$10X$$
$$\text{Power cost} = \$5,000 + \$4X$$
$$\text{Setup cost} = \$100,000$$

KELLY: I think I see the problem. Power costs don't have a lot to do with direct labour hours. They have more to do with machine hours. As production increases, machine hours increase more rapidly than direct labour hours. Also, . . .

JOHN: You know, you have a point. The coefficient of determination for power cost is only about 50 percent. That leaves a lot of unexplained cost variation. The coefficient for labour, however, is much better—it explains about 96 percent of the cost variation. Setup costs, of course, are fixed.

KELLY: Well, as I was about to say, setup costs also have very little to do with direct labour hours. And I might add that they certainly are not fixed—at least not all of them. We had to do more setups than our original plan called for because of the scheduling changes. And we have to pay our people when they work extra hours. It seems as if we are always paying overtime. I wonder if we simply do not have enough people for the setup activity. Supplies are used for each setup, and these are not cheap. Did you build these extra costs of increased setup activity into your budget?

JOHN: No, we assumed that setup costs were fixed. I see now that some of them could vary as the number of setups increases. Kelly, let me see if I can develop some cost formulas based on better explanatory variables. I'll get back with you in a few days.

Assume that after a few days' work, John developed the following cost formulas, all with a coefficient of determination greater than 90 percent:

$$\text{Labour cost} = \$10X, \text{ where } X = \text{Direct labour hours}$$
$$\text{Power cost} = \$68,000 + 0.9Y, \text{ where } Y = \text{Machine hours}$$
$$\text{Setup cost} = \$98,000 + \$400Z, \text{ where } Z = \text{Number of setups}$$

The actual measures of each of the activity drivers are as follows:

Direct labour hours	20,000
Machine hours	90,000
Number of setups	110

Required:

1. Prepare a performance report for direct labour, power, and setups using the direct-labour-based formulas.
2. Prepare a performance report for direct labour, power, and setups using the multiple cost driver formulas that John developed.
3. Of the two approaches, which provides the most accurate picture of Kelly's performance? Why?
4. After reviewing the approach to performance measurement, a consultant remarked that non-value-added cost trend reports would be a much better performance measurement approach than comparing actual costs with budgeted costs—even if activity flexible budgets were used. Do you agree or disagree? Explain.

CMA Problem

OBJECTIVE 2 3 5

CMA Problem 14-1 ACTIVITY FLEXIBLE BUDGETING, NON-VALUE-ADDED COSTS*

Wendy Li, controller for Marston Inc., prepared the following budget for manufacturing costs at two different levels of activity for 2013:

	Level of Activity	
Driver: Direct Labour Hours	*50,000*	*100,000*
Direct materials	$ 300,000	$ 600,000
Direct labour	200,000	400,000
Depreciation (plant)	100,000	100,000
Subtotal	$ 600,000	$1,100,000

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	Level of Activity	
Driver: Machine Hours	*200,000*	*300,000*
Maintaining equipment	$ 360,000	$ 510,000
Machining	112,000	162,000
Subtotal	$ 472,000	$ 672,000
Driver: Material Moves	*20,000*	*40,000*
Moving materials	$ 165,000	$ 290,000
Driver: Number of Batches Inspected	*100*	*200*
Inspecting products	$ 125,000	$ 225,000
Total	$1,362,000	$2,287,000

During 2013, Marston worked a total of 80,000 direct labour hours, used 250,000 machine hours, made 32,000 moves, and performed 120 batch inspections. The following actual costs were incurred:

Direct materials	$440,000
Direct labour	355,000
Depreciation	100,000
Maintaining equipment	425,000
Machining	142,000
Moving materials	232,500
Inspecting products	160,000

Marston applies overhead using rates based on direct labour hours, machine hours, number of moves, and number of batches. The second level of activity (the right column in the preceding table) is the practical level of activity (the available activity for resources acquired in advance of usage) and is used to compute predetermined overhead pool rates.

Required:

1. Prepare a performance report for Marston's manufacturing costs in 2013.
2. Assume that one of the products produced by Marston is budgeted to use 10,000 direct labour hours, 15,000 machine hours, and 500 moves and will be produced in five batches. A total of 10,000 units will be produced during the year. Calculate the budgeted unit manufacturing cost.
3. One of Marston's managers said the following: "Budgeting at the activity level makes a lot of sense. It really helps us manage costs better. But the previous budget really needs to provide more detailed information. For example, I know that the moving materials activity involves the use of forklifts and operators, and this information is lost when only the total cost of the activity for various levels of output is reported. We have four forklifts, each capable of providing 10,000 moves per year. We lease these forklifts for five years, at $10,000 per year. Furthermore, for our two shifts, we need up to eight operators if we run all four forklifts. Each operator is paid a salary of $30,000 per year. Also, I know that fuel costs about $0.25 per move."

   Assuming that these are the only three items, expand the detail of the flexible budget for moving materials to reveal the cost of these three resource items for 20,000 moves and 40,000 moves, respectively. Based on these comments, explain how this additional information can help Marston better manage its costs. (Especially consider how activity-based budgeting may provide useful information for non-value-added activities.) *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

Integrative Exercise 3

Part 3
Chapters 11–14

Sabrina Hoffman is founder and CEO of Golden Care Inc., which owns and operates several assisted-living facilities. The facilities are apartment-style buildings with 25 to 30 one- or two-bedroom apartments. While each apartment has its own complete kitchen, in every building Golden Care offers communal dining options and an on-site nurse who is available 24 hours a day. Residents can choose monthly meal options that include one or two meals per day in the dining room. Residents who require nursing services (e.g., blood pressure monitoring and injections) can receive those services from the nurse. However, Golden Care facilities are not nursing homes, all residents are ambulatory, and custodial care is not an option. In the five years it has been in operation, the company has expanded from one facility to five, located in Maritime cities. The income statement for last year follows.

Golden Care Inc.
Income Statement for Last Year

Revenue	$2,880,000
Cost of services	2,016,000
Gross profit	864,000
Marketing and administrative expenses	500,000
Operating income	$ 364,000

Sabrina originally got into the business because she had trouble finding adequate facilities for her mother. The concept worked well, and income over the past five years had grown nicely at 20 percent per year. However, Sabrina sensed clouds on the horizon. She knew that the population was aging and that her current clients would be moving to more traditional forms of nursing care. As a result, Sabrina wanted to consider adding one or more nursing homes to Golden Care. These nursing homes would be staffed around the clock with RNs and LPNs. The residents would likely have more severe medical problems and would be confined to beds or wheelchairs. Sabrina knew that quality care of this type was needed. So, she contacted Peter Verdon, her marketing manager, and Bernadette Zhang, her accountant, for a brainstorming session.

Peter: Sabrina, I really like the concept. As you know, several of our facilities have faced seeing their long-term residents move out to local nursing homes. Not only are these homes of lower quality than what we could provide, but losing a resident is heartrending for the staff, as well as for the remaining residents. I like the idea of providing a transition from less care to more.

Bernadette: I agree with you, Peter. But let's not forget the differences between assisted-living and full-time, nursing-home-type care. Our expenses will really increase.

Sabrina: That's why I wanted to talk with both of you. As you know, Golden Care's mission statement emphasizes the need to make a profit. We can't continue to serve our residents and provide high-quality care if we don't make enough money to pay our staff a living wage and earn enough of a profit to smooth over the rough patches and continue to improve our business. Could the two of you look into this idea, and get back to me in a week or so?

Throughout the following week, the three communicated by e-mail. By the end of the week, a number of possibilities had surfaced, and these were summarized in a message from Bernadette to the others.

TO: sabrina.hoffman@goldencare.com, peter.verdon@goldencare.com
FROM: bernadette.zhang@goldencare.com
MESSAGE:
I've compiled the ideas from all of our e-mails into the following list. This may be a good starting point for our meeting tomorrow.

1. Buy an existing nursing home in one of Golden Care's current locations.
2. Buy an existing nursing home in another city.

3. Build a new nursing home facility in one of Golden Care's current locations.
4. Build a new nursing home facility in another city.
5. Build a wing on to an existing Golden Care facility. The Huron Junction facility has sufficient open land for an addition.

The next day, Sabrina, Peter, and Bernadette met again in Sabrina's office.

Sabrina: I didn't realize there were so many possibilities. Are we going to have to work up numbers on each of them?

Bernadette: No, I think we can eliminate a few of them pretty quickly. For example, building a new facility would cost more than the other options, and it would involve the most risk.

Peter: I agree, and I also think we might eliminate the purchase of an existing nursing home for the same reasons. Also, existing homes would not give us the option of building a facility that is state of the art and meets our needs, and it would lock us into a preexisting patient mix.

Sabrina: I like that thinking. Let's restrict our attention to Option 5.

Bernadette: I thought you might like that option, so Peter and I sketched out two alternatives for an extension of the Huron Junction building. We call the alternatives Basic Care and Lifestyle Care.

Peter: There are different markets for each type of care. If we want to concentrate on government-supported patients, the reimbursement is lower, and we would want to offer the Basic Care option. Private insurance and private-pay patients could afford more services; if we are marketing to these patients, we could offer the Lifestyle Care option. Both alternatives provide high-quality nursing care. Basic Care concentrates on the quality nursing and maintenance activities. For example, the addition would have 25 double rooms, two nursing stations, two recreation rooms, a treatment room, and an office. The Lifestyle Care option adds physical and recreational therapy with a specially equipped gym and pool. That addition would have 30 single rooms, two nursing stations, a recreation room, a swimming pool, a hydrotherapy spa and gym, a treatment room, and an office. In each case, there would be cable TV and telephone hookups in each room and a buffer area between the nursing home and the apartments.

Sabrina: Why the buffer area? Won't that add unnecessary cost?

Peter: It adds cost, but it will be well worth it. Sabrina, you must remember that the nursing home patients are different from the apartment residents. Some of the patients will have advanced dementia. We'll lose apartment residents in a hurry if they have to be reminded every day of what might be in store for them later on.

Sabrina: I see your point. Bernadette, what will these two plans cost? I'll tell you right now that I like the Lifestyle Care option better. It fits with our history of doing whatever we can to make life better for our residents.

Bernadette: I've checked into the costs of putting on a new wing and operating both alternatives. Here's a listing.

Basic Care		Lifestyle Care	
Construction	$1,500,000	Construction	$2,000,000
Annual operating expenses:		Annual operating expenses:	
Staff:		Staff:	
RNs (3 × $30,000)	90,000	RNs (3 × $30,000)	90,000
LPNs (6 × $22,000)	132,000	LPNs (6 × $22,000)	132,000
Aides (6 × $20,000)	120,000	Aides (6 × $20,000)	120,000
Cooks (2 × $15,000)	30,000	Physical and recreational therapists (2 × $25,000)	50,000
Janitors (2 × $18,000)	36,000	Cooks (1.5 × $15,000)	22,500
Other* (60% variable)	300,000	Janitors (2 × $18,000)	36,000
Debt service	150,000	Other (60% variable)	360,000
Depreciation (over 20 years)	75,000	Debt service	200,000
		Depreciation (over 20 years)	100,000

* Other includes supplies, utilities, food, and so on.

In both cases, total administrative costs for Golden Care would increase by $30,000 per year. This seems high, but the increased legal and insurance requirements will add significantly more paperwork and accounting.

Sabrina: All this sounds reasonable, but why is reimbursement such an important factor?

Peter: Well, if you admit government-supported patients, the province will reimburse at most $30,000 per year. Private insurance policies will pay roughly $46,000 per year. We can charge up to about $65,000 for private patients, but this type of care is so expensive that many of these patients exhaust their own funds. The nice aspect of government-supported patients is that we can be virtually assured that we will operate at capacity.

Sabrina: Can we cross that bridge when we come to it?

Peter: No, not really. Once the patient is a resident of our facility, it is hard to evict him or her. Also, while it is legal to force patients out before they go on government support and to refuse to accept government-supported patients, once we do accept government-supported patients, we are prevented by law from evicting them—no matter how high our costs go.

Sabrina: OK, it looks as if we have some hard work ahead of us to decide whether or not to get into this line of business.

Required:

1. How did Sabrina, Bernadette, and Peter use the tactical decision-making model of Chapter 11?
2. Categorize each of the expenses for the Basic Care and Lifestyle Care options as flexible or committed. Further categorize the committed expenses as committed fixed or committed step costs.
3. Calculate the break-even number of patients (in total and for each type of reimbursement) for each of the following scenarios:
   a. Basic Care option, 20 percent private insurance and 80 percent government supported
   b. Basic Care option, no government support
   c. Lifestyle Care option, no government support, 75 percent private insurance, 25 percent private pay
   d. Lifestyle Care option, all insurance reimbursement
4. What is the markup percent of cost of services charged on the assisted-living expenses? What would the price per month for a Basic Care patient be if the same markup were used? For a Lifestyle Care patient? (Assume in both cases that occupancy is at 80 percent of capacity.)
5. What is the payback period for the new addition?
6. Research Assignment: What is the relevant law restricting the ability of nursing homes to evict government-supported patients? Why would nursing homes accept government-supported patients and later evict them? Is eviction of government-supported patients still a problem? Discuss the legal and ethical issues in a nursing home's decision on whether to accept government-supported patients.

Part 4 STRATEGIC COST MANAGEMENT

The first three parts of this textbook have focused on the nature of costs and on how the organization can be influenced to perform in a certain manner. However, once a manager has learned the tools and techniques to understand and control costs within an organization, the question that must be asked is "How does this fit with the organization's strategy?"

Management must establish the strategic direction that an organization will pursue before entering the planning and management cycle. Once this strategic direction is established, everything else the organization does must be consistent with the strategy set forth. The tools and techniques discussed earlier must enable the organization to pursue not only a strong cost management program but also its strategic objectives.

There are a number of approaches that allow management to ensure that the organization's strategic objectives are not being sacrificed in the name of "cost control." In recent years, there has been increased emphasis on nonfinancial measures and structural changes to ensure that the organization as a whole is operating at the most efficient level possible.

Part 4 of this text introduces a number of the approaches to preserving the strategic direction while still allowing the organization to achieve the best possible results for its shareholders, managers, employees, and all other stakeholders.

After studying this chapter, you should be able to:

1. Compare and contrast activity-based and strategic-based responsibility accounting systems.
2. Discuss the basic features of the Balanced Scorecard.
3. Explain how the Balanced Scorecard links measures to strategy.
4. Describe how an organization can achieve strategic alignment.

CHAPTER

15 The Balanced Scorecard: Strategic-Based Control

Many firms operate in an environment where change is rapid. Products and processes are constantly being redesigned and improved, and stiff national and international competitors are always present. The competitive environment demands that firms offer customized products and services to diverse customer segments. This, in turn, means that firms must find cost-efficient ways of producing high-variety, low-volume products. This usually means that more attention is paid to linkages between the firm and its suppliers and customers with the goal of improving cost, quality, and response times for all parties in the value chain. Furthermore, for many industries, product life cycles are shrinking, placing greater demands on the need for innovation. Thus, organizations operating in a dynamic, rapidly changing environment are finding that adaptation and change are essential to survival. In Chapter 6, we learned that activity-based management describes the fundamental economics that drive a firm and thus allows managers to have a better understanding of the causes of cost. In turn, understanding the root causes of costs enables managers to more effectively improve performance by continuously improving processes.

Activity-based management also produced a new form of responsibility accounting, one that better fits environments that demand continuous improvement because of keen competitive conditions and dynamic change. Recall that the responsibility accounting model is defined by four essential elements: (1) assigning responsibility, (2) establishing performance measures or benchmarks, (3) evaluating performance, and (4) assigning rewards. The traditional or financial-based responsibility accounting model emphasizes financial performance of organizational units and evaluates and rewards performance using static financial-oriented standards (e.g., budgets and standard costing). While this model is useful for firms operating in a stable environment that wish to emphasize maintaining the status quo, it is certainly not suitable for firms operating in a dynamic environment that requires continuous improvement. For this reason, activity-based responsibility accounting was developed. (Chapter 14 detailed the differences between the two models.) However, while the activity-based responsibility accounting model was a significant improvement, it soon became apparent that it suffered from some limitations. This then led to the development of *strategic-based responsibility accounting*, the topic of this chapter.

Activity-Based versus Strategic-Based Responsibility Accounting

OBJECTIVE 1
Compare and contrast activity-based and strategic-based responsibility accounting systems.

Activity-based responsibility accounting represents a significant change in how responsibility is assigned, measured, and evaluated. Effectively, the activity-based system added a process perspective to the financial perspective of the functional-based responsibility accounting system. Processes represent how things are done within an organization; therefore, any effort to improve organizational performance had to involve improving processes. It also altered the financial perspective by changing the point of view from that of cost control to maintain the status quo to that of cost reduction by continuous learning and change. Thus, responsibility accounting changed from a one-dimensional system to a two-dimensional system, and from a control system to a *performance management system*. Although these changes were dramatic and in the right direction, it was soon discovered that the new approach also had some limitations. The most significant shortcoming was the fact that the continuous improvement efforts were often fragmented, and they failed to connect with an organization's overall mission and strategy. Lacking was a navigational system, and the result was undirected and rudderless continuous improvement. Consequently, at times, the expected competitive successes did not materialize.

What was needed was *directed continuous improvement*. Providing direction meant that managers needed to carefully specify a mission and strategy for their organization and identify the objectives, performance measures, and initiatives necessary to accomplish this overall mission and strategy. In other words, a strategic-based responsibility accounting system was the next step in the evolution of responsibility accounting. A **strategic-based responsibility accounting system (strategic-based performance management system)** translates the strategy of an organization into operational objectives and measures. A strategic performance management system can assume different forms, the most common being that of the Balanced Scorecard. The **Balanced Scorecard** is a strategic-based performance management system that typically identifies objectives and measures for four different perspectives: the financial perspective, the customer perspective, the process perspective, and the learning and growth perspective.[1]

The Balanced Scorecard converts a company's strategy into executable actions that are deployed throughout the organization. The Balanced Scorecard approach has spread rapidly in the United States and throughout the world. A **Bain & Company** survey of a broad range of international executives revealed that in 2008, 53 percent of the companies surveyed were using the Balanced Scorecard.[2] The usage rate

[1] Robert S. Kaplan and David P. Norton, *The Balanced Scorecard* (Boston: Harvard Business School Press, 1996).

[2] Darrell Rigby and Barbara Bilodeau, "Management Tools and Trends 2009," Bain & Company, http://www.bain.com/management_tools/home.asp (accessed June 1, 2009).

ranged from 49 percent in North America to 56 percent in Latin America. Global usage was expected to expand to 63 percent within a year. Because of its widespread use and popularity, we will focus our discussion of performance management on the Balanced Scorecard. A general overview of the Balanced Scorecard will first be provided by comparing the specific responsibility elements of activity-based responsibility accounting with those of the Balanced Scorecard. In the remainder of the chapter, more specific details of the Balanced Scorecard will be provided.

Assigning Responsibility

Exhibit 15-1A reveals that the strategic-based responsibility accounting system adds direction to improvement efforts by tying responsibility to the firm's strategy. It also maintains the process and financial perspectives of the activity-based approach but adds a customer and a learning and growth (infrastructure) perspective, increasing the number of responsibility dimensions to four. Although more perspectives could be added, these four perspectives are essential for creating a competitive advantage and allowing managers to articulate and communicate the organization's mission and strategy. Only perspectives that serve as a potential source for a competitive advantage should be included (e.g., an environmental perspective). This leaves open the possibility of expanding the number of perspectives. Notice that the two additional perspectives consider the interests of customers and employees, interests that were not fully considered by the activity-based responsibility system. Another difference is that the Balanced Scorecard diffuses responsibility for the perspectives throughout the entire organization. Ideally, all individuals in the organization should understand the organization's strategy and know how their specific responsibilities support achievement of the strategy. The key to this diffusion is proper and careful definition of performance measures.

Establishing Performance Measures

Exhibit 15-1B reveals that the strategic-based approach carries over the financial and process-oriented standards of the activity-based system, including the concepts of value-added and dynamic standards. None of the advances developed in an activity approach are thrown out, but the strategic-based approach adds some important refinements. In a strategic-based responsibility accounting system, performance measures must be integrated so that they are mutually consistent and reinforcing. In effect, performance measures should be designed so that they are derived from and communicate an organization's strategy and objectives. By translating the organization's strategy into objectives and measures that can be understood, communicated, and acted upon, it is possible to more completely align individual and organizational goals and initiatives. Thus, the measures must be balanced and linked to the organization's strategy.

When a firm has balanced measures, the measures selected are balanced between *lag measures* and *lead measures*, between *objective measures* and *subjective measures*, between *financial measures* and *nonfinancial measures*, and between *external measures* and *internal measures*. **Lag measures** are outcome measures—measures of results from past efforts (e.g., customer profitability). **Lead measures (performance drivers)** are factors that drive future performance (e.g., hours of employee training). **Objective measures** are those that can be readily quantified and verified (e.g., market share), whereas **subjective measures** are less quantifiable and more judgmental in nature (e.g., employee capabilities). **Financial measures** are those expressed in monetary terms, whereas **nonfinancial measures** use nonmonetary units (e.g., number of dissatisfied customers). **External measures** are those that relate to *customers* versus *shareholders* (e.g., customer satisfaction and return on investment). **Internal measures** are those measures that relate to the *processes* and *capabilities* that create value for customers and shareholders (e.g., process efficiency and employee satisfaction).

A strategic performance management system uses many different kinds of measures because of the need to build a closer link to strategy. In the traditional, financial-based responsibility model, performance measures are almost always financial and,

Exhibit 15-1

Responsibility, Performance, and Reward

A. Responsibility Assignments Compared

Activity-Based Responsibility	Strategic-Based Responsibility
1. No tie to strategy	1. Linked to strategy
2. Systemwide efficiency	2. Systemwide efficiency
3. Team accountability	3. Team accountability
4. Financial perspective	4. Financial perspective
5. Process perspective	5. Process perspective
	6. Customer perspective
	7. Learning and growth perspective

B. Performance Measures Compared

Activity-Based Measures	Strategic-Based Measures
1. Process-oriented and financial standards	1. Standards for all four perspectives
2. Value-added standards	2. Used to communicate strategy
3. Dynamic standards	3. Used to help align objectives
4. Optimal standards	4. Linked to strategy and objectives
	5. Balanced measures

C. Performance Evaluation Compared: Activity-Based versus Strategic-Based

Activity-Based Performance Evaluation	Strategic-Based Performance Evaluation
1. Time reductions	1. Time reductions
2. Quality improvements	2. Quality improvements
3. Cost reductions	3. Cost reductions
4. Trend measurements	4. Trend measurements
	5. Expanded set of metrics
	6. Stretch targets for all four perspectives

D. Rewards Compared

Activity-Based Rewards	Strategic-Based Rewards
1. Performance evaluated on two or more dimensions	1. Performance evaluated on four or more dimensions
2. Group rewards	2. Group rewards
3. Salary increases	3. Salary increases
4. Promotions	4. Promotions
5. Bonuses, profit sharing, and gainsharing	5. Bonuses, profit sharing, and gainsharing

therefore, almost always lag measures. Financial and lag measures are not sufficient to link with strategy. Many strategic objectives are nonfinancial in nature and require the use of nonfinancial measures to promote and measure progress. For example, increasing customer loyalty may be a key strategic objective that will lead to increased revenues and profits. Yet how is customer loyalty measured? The number of repeat orders is a good possible measure, and it is a nonfinancial measure. And what are

some of the drivers of customer loyalty? Increasing product quality? Increasing on-time deliveries? Or both? And how are these critical success factors measured? Percentage of defective units and percentage of on-time deliveries are good possibilities. Clearly, to express the desired linkages among strategic objectives, nonfinancial measures are needed.

The concept of lead measures is also critical. A lead measure, by definition, is one that has a causal linkage with the strategy. For example, if the number of defective units decreases, will customer loyalty actually increase? If the number of repeat orders increases, will revenues and profits actually increase? Assuming a causal relationship exists, when in reality it does not, can be quite costly. For example, **Xerox** assumed that increasing customer satisfaction would lead to increased financial performance. It then spent millions on surveying and measuring customer satisfaction only to discover that increasing customer satisfaction did not increase financial performance. As it turned out, a customer loyalty measure was the correct lead measure for improving financial performance.[3]

Finally, it should be noted that to communicate an organization's strategy through the language of measurement requires both scope and flexibility. Scope implies that both internal and external measures are needed. Flexibility requires subjective and objective measurement as well as nonfinancial measures. In effect, a Balanced Scorecard expresses the complete story of a company's strategy through an integrated set of financial and nonfinancial measures that are both predictive and historical and that may be measured subjectively or objectively.

Performance Measurement and Evaluation

In an activity-based responsibility system, performance measures are process oriented. Thus, performance evaluation focuses on improvement of process characteristics, such as time, quality, and efficiency. Financial consequences of improving processes are also measured, usually by cost reductions achieved. Therefore, a financial perspective is included. A strategic performance management system expands these evaluations to include the customer and learning and growth perspectives as well as a more comprehensive financial view. The organization must also deal with performance evaluation of things, such as customer satisfaction, customer retention, employee capabilities, and revenue growth from new customers and new products. However, the difference is more profound than simply expanding the number and type of measures being evaluated. Exhibit 15-1C summarizes the comparison of performance evaluation for the activity and strategic-based approaches.

Performance evaluation in a Balanced Scorecard framework is deeply concerned with the effectiveness and viability of the organization's strategy. Furthermore, the Balanced Scorecard approach is used to drive organizational change, and much of this change emphasis is expressed through performance evaluation. This is communicated by establishing *stretch* targets for the individual performance measures of the various perspectives. **Stretch targets** are targets that are set at levels that, if achieved, will transform the organization within a period of three to five years. Performance for a given period is evaluated by comparing the actual values of the various measures with the targeted values. Two key features make stretch targets feasible: (1) the measures are linked by causal relationships and (2) because of the linkages, the targets are not set in isolation but rather through a consensus of all those in the organization. Exhibit 15-1D reveals that the reward method of the two systems are strikingly similar and differ only on the number of dimensions being evaluated.

Assigning Rewards

For any performance management system to be successful, the reward system must be linked to the performance measures. The activity- and strategic-based systems both

[3] Christopher Ittner and David Larcker, "Coming Up Short on Nonfinancial Performance Measurement," *Harvard Business Review* (November 2003): 88–95.

use the same financial instruments to provide compensation to those who achieve targeted performance goals. A key difference for both systems from the traditional control system is the fact that rewards are based on much more than financial measures. In the case of the Balanced Scorecard, four dimensions of performance must be considered instead of the two in an activity-based performance system. It is very unlikely that an organization can secure the needed support for a Balanced Scorecard of measures unless compensation is tied to the scorecard measures. Both systems must also face the thorny problem of team-based rewards.

Basic Concepts of the Balanced Scorecard

OBJECTIVE 2
Discuss the basic features of the Balanced Scorecard.

The Balanced Scorecard permits an organization to create a strategic focus by *translating* an organization's strategy into operational objectives and performance measures for four different perspectives: the financial perspective, the customer perspective, the internal business process perspective, and the learning and growth (infrastructure) perspective. The Balanced Scorecard is an effective way of implementing and managing a company's strategy. A number of companies attribute their recent financial success to this strategic performance management system.

Strategy Translation

Strategy, according to the creators of the Balanced Scorecard framework, is defined as:[4]

> *choosing the market and customer segments the business unit intends to serve, identifying the critical internal and business processes that the unit must excel at to deliver the value propositions to customers in the targeted market segments, and selecting the individual and organizational capabilities required for the internal, customer, and financial objectives.*

Strategy, then, is identifying and defining management's desired relationships among the four perspectives. *Strategy translation*, on the other hand, means specifying objectives, measures, targets, and initiatives for each perspective. The strategy translation process is illustrated in Exhibit 15-2. Consider, for example, a company that wishes to pursue a revenue growth strategy. For the financial perspective, the company may specify an *objective* of growing revenues by introducing new products. The *performance measure* may be the percentage of revenues from the sale of new products. The *target* or *standard* for the coming year for the measure may be 20 percent. (That is, 20 percent of the total revenues for the coming year must be from the sale of new products.) The *initiative* describes *how* this is to be accomplished. The "how," of course, involves the other three perspectives. The customer segments, internal processes, and individual and organizational capabilities that will permit the realization of the revenue growth objective must now be identified. This illustrates the fact that the financial objectives serve as the focus for the objectives, measures, and initiatives of the other three perspectives. It also illustrates the need to carefully define the relationships among the four perspectives so that strategy becomes visible and operational. However, before examining how these causal relationships define and operationalize the strategy, we first need a better understanding of the four perspectives, their objectives, and their measures.

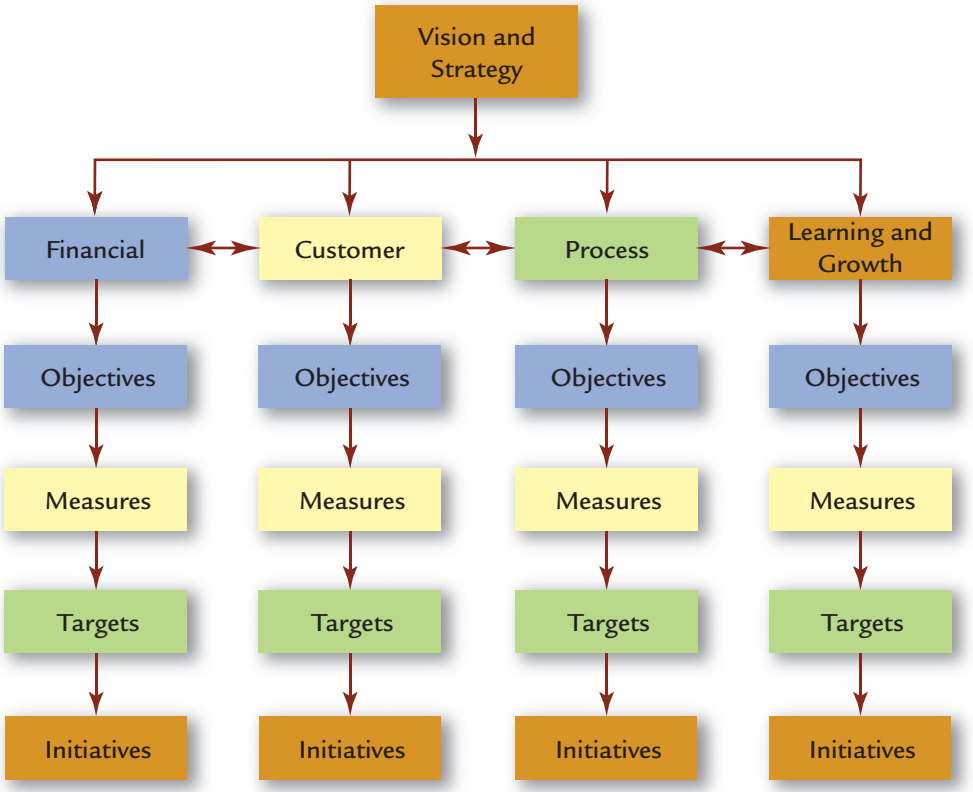
1. The Financial Perspective, Objectives, and Measures

The **financial perspective** establishes the long- and short-term financial performance objectives expected from the organization's strategy and simultaneously describes the

[4] Kaplan and Norton, *The Balanced Scorecard*, 37.

Exhibit 15-2

Strategy Translation Process



economic consequences of actions taken in the other three perspectives. This implies that the objectives and measures of the other perspectives should be chosen so that they cause or bring about the desired financial outcomes. The financial perspective has three strategic themes: revenue growth, cost reduction, and asset utilization. These themes serve as the building blocks for the development of specific operational objectives and measures. Of course, the three themes are constrained by the need for managers to manage risk.

Revenue Growth Increasing revenues can be achieved in a variety of ways, and the potential strategic objectives reflect these possibilities. Among these possibilities are the following objectives: increase the number of new products, create new applications for existing products, develop new customers and markets, and adopt a new pricing strategy. Once operational objectives are known, performance measures can be designed. Possible measures for the preceding list of objectives (in the order given) are percentage of revenue from new products, percentage of revenue from new applications, percentage of revenues from new customers and market segments, and profitability by product or customer.

Cost Reduction Reducing the cost per unit of product, per customer, or per distribution channel are examples of cost reduction objectives. The appropriate measures are obvious: costs per unit of the particular cost objects. Trends in these measures will tell whether or not the costs are being reduced. For these objectives, the accuracy of cost assignments is especially important. Activity-based costing can play an essential measurement role, especially for selling and administrative costs—costs not usually assigned to cost objects like customers and distribution channels.

Asset Utilization Improving asset utilization is the principal objective. Financial measures such as return on investment and economic value added are used. Since return on investment and economic value-added measures were discussed in detail in Chapter 10, they will not be discussed here. The objectives and measures for the financial perspective are summarized in Exhibit 15-3A.

Risk Management Managing the risk associated with the adopted strategy is another critical strategic theme—one that is common to the three strategic financial themes already discussed. Diversification of customer types, product lines, and suppliers are common means of lowering risk. Sourcing materials from only one supplier may lower costs, but it may also jeopardize the firm's throughput if something happens to the supplier (e.g., a labour strike). Similarly, revenues may be increased by relying on one very large customer—but what happens if the customer decides to buy elsewhere? Thus, any strategic initiative must be balanced with careful consideration of the risk involved.

2. Customer Perspective, Objectives, and Measures

The **customer perspective** defines the customer and market segments in which the business unit will compete and describes the way that value is created for customers. The customer perspective is the source of the revenue component for the financial objectives. Failure to deliver the right kinds of products and services to the targeted customers means revenue will not be generated.

Once the customers and segments are defined, *core objectives* and *measures* are developed. **Core objectives and measures** are those that are common across all organizations. There are five key core objectives: increase market share, increase customer retention, increase customer acquisition, increase customer satisfaction, and increase customer profitability. Possible core measures for these objectives, respectively, are market share (percentage of the market), percentage growth of business from existing customers and percentage of repeating customers, number of new customers, ratings from customer satisfaction surveys, and individual and segment profitability. Activity-based costing is a key tool in assessing customer profitability (see Chapter 13). Notice that customer profitability is the only financial measure among the core measures. This measure, however, is critical because it emphasizes the importance of the *right* kind of customers. What good is it to have customers if they are not profitable? The obvious answer spells out the difference between being customer focused and customer obsessed.

Customer Value In addition to the core measures and objectives, measures are needed that drive the creation of *customer value* and, thus, drive the core outcomes. For example, increasing customer value builds customer loyalty (increases retention) and increases customer satisfaction. **Customer value** is the difference between realization and sacrifice, where realization is what the customer receives and sacrifice is what is given up. Realization includes such attributes as product functionality (features), product quality, reliability of delivery, delivery response time, image, and reputation. Sacrifice includes attributes such as product price, time required to learn to use the product, operating cost, maintenance cost, and disposal cost. The costs incurred by the customer *after* purchase are called **post-purchase costs**.

The attributes associated with realization and sacrifice provide the basis for the objectives and measures that will lead to improving the core outcomes. The objectives for the sacrifice side of the value equation are the simplest: decrease price and decrease post-purchase costs. Selling price and post-purchase costs are important measures of value creation. Decreasing these costs decreases customer sacrifice, and, thus, increases customer value. Increasing customer value should impact favourably on most of the core objectives. Similar favourable effects can be obtained by increasing realization. Realization objectives, for example, would include the following: improve product functionality, improve product quality, increase delivery reliability, and improve product image and reputation. Possible measures for these objectives include, respectively, feature satisfaction ratings, percentage of returns, on-time delivery percentage, and

Exhibit 15-3

Objectives and Measures: Financial, Customers, Process, and Learning/ Growth Perspectives

A. Summary of Objectives and Measures: Financial Perspective

Objectives	Measures
Revenue Growth:	
Increase the number of new products	Percentage of revenues from new products
Create new applications	Percentage of revenues from new applications
Develop new customers and markets	Percentage of revenues from new sources
Adopt a new pricing strategy	Product and customer profitability
Cost Reduction:	
Reduce unit product cost	Unit product cost
Reduce unit customer cost	Unit customer cost
Reduce distribution channel cost	Cost per distribution channel
Asset Utilization:	
Improve asset utilization	Return on investment Economic value added

B. Summary of Objectives and Measures: Customer Perspective

Objectives	Measures
Core:	
Increase market share	Market share (percentage of market)
Increase customer retention	Percentage growth, existing customers Percentage of repeating customers
Increase customer acquisition	Number of new customers
Increase customer satisfaction	Ratings from customer surveys
Increase customer profitability	Customer profitability
Performance Value:	
Decrease price	Price
Decrease post-purchase costs	Post-purchase costs
Improve product functionality	Ratings from customer surveys
Improve product quality	Percentage of returns
Increase delivery reliability	On-time delivery percentage Aging schedule
Improve product image and reputation	Ratings from customer surveys

product recognition rating. Of these objectives and measures, delivery reliability will be used to illustrate how measures can affect managerial behaviour, indicating the need to be careful in the choice and use of performance measures.

Delivery reliability means that output is delivered on time. On-time delivery is a commonly used operational measure of reliability. To measure on-time delivery, a firm sets delivery dates and then finds on-time delivery performance by dividing the orders delivered on time by the total number of orders delivered. The goal, of course, is to achieve a ratio of 100 percent. However, this measure used by itself may produce undesirable behavioural consequences.[5] For example, plant managers may give priority to filling orders not yet late over orders that are already late. The performance measure here is encouraging managers to have one very late shipment rather than several moderately late shipments! A chart measuring the age of late deliveries could help mitigate this problem. Exhibit 15-3B summarizes the objectives and measures for the customer perspective.

[5] Joseph Fisher, "Nonfinancial Performance Measures," *Journal of Cost Management* (Spring 1992): 31–38.

C. Summary of Objectives and Measures: Process Perspective

Objectives	Measures
Innovation:	
Increase the number of new products	Number of new products/total products; R&D expenses
Increase proprietary products	Percentage revenue from proprietary products
	Number of patents pending
Decrease product development cycle time	Time to market (from start to finish)
Operations:	
Increase process quality	Quality costs
	Output yields
	Percentage of defective units
Increase process efficiency	Unit cost trends
	Output/input(s)
Decrease process time	Cycle time and velocity
	MCE
Post-Sales Service:	
Increase service quality	First-pass yields
Increase service efficiency	Cost trends
	Output/input(s)
Decrease service time	Cycle time

D. Summary of Objectives and Measures: Learning and Growth Perspective

Objectives	Measures
Increase employee capabilities	Employee satisfaction ratings
	Employee turnover percentages
	Employee productivity (revenue/employee)
	Hours of training
	Strategic job coverage ratio (percentage of critical job requirements filled)
Increase motivation and alignment	Suggestions per employee
	Suggestions implemented per employee
Increase information systems capabilities	Percentage of processes with real-time feedback capabilities
	Percentage of customer-facing employees with online access to customer and product information

3. Process Perspective, Objectives, and Measures

The **internal business process perspective** describes the internal processes needed to provide value for customers and owners. Processes are the means by which strategies are executed. Thus, the process perspective entails the identification of the critical processes needed that affect customer and shareholder satisfaction. To provide the framework needed for this perspective, a *process value chain* is defined. The **process value chain** is made up of three processes: the *innovation process*, the *operations process*, and the *post-sales service process*.[6] The **innovation process** anticipates the emerging and potential needs of customers and creates new products and services to satisfy those needs. It represents what is called the *long wave* of value creation. The **operations process** produces and delivers *existing* products and services to customers. It begins

[6] Kaplan and Norton, *The Balanced Scorecard*, 96.

with a customer order and ends with the delivery of the product or service. It is the *short wave* of value creation. The **post-sales service process** provides critical and responsive services to customers after the product or service has been delivered.

Innovation Process: Objectives and Measures Objectives for the innovation process include the following: increase the number of new products, increase percentage of revenue from proprietary products, and decrease the time to develop new products. Associated measures are actual new products developed versus planned products, percentage of total revenues from new products, percentage of revenues from proprietary products, and development cycle time (time to market).

Operations Process: Objectives and Measures Three operations process objectives are almost always mentioned and emphasized: increase process quality, increase process efficiency, and decrease process time. Examples of process quality measures are quality costs, output yields (good output/good input), and percentage of defective units (good output/total output). Quality costing and control are discussed extensively in Chapter 16. Measures of process efficiency are concerned mainly with process cost and process productivity. Measuring and tracking process costs is facilitated by activity-based costing and process value analysis. These issues were explored in depth in the activity-based management chapter (Chapter 14). Productivity measurement is explored in Chapter 17. Common process time measures are cycle time, velocity, and manufacturing cycle efficiency (MCE).

Cycle Time and Velocity The time it takes a company to respond to a customer order is referred to as *responsiveness. Cycle time* and *velocity* are two operational measures of responsiveness. **Cycle time (manufacturing)** is the length of time it takes to produce a unit of output from the time materials are received (starting point of the cycle) until the good is delivered to finished goods inventory (finishing point of the cycle).[7] Thus, cycle time is the time required to produce a product (time/units produced). **Velocity** is the number of units of output that can be produced in a given period of time (units produced/time). Although cycle time has been defined for the operations process, it is defined in a similar way for innovation and post-sales service processes. For example, how long does it take to create a new product and introduce it to the market? Or, how long does it take to resolve a customer complaint (from start to finish)?

Incentives can be used to encourage operational managers to reduce manufacturing cycle time or to increase velocity, thus improving delivery performance. A natural way to accomplish this objective is to tie product costs to cycle time and reward operational managers for reducing product costs. For example, in a JIT firm, cell conversion costs can be assigned to products on the basis of the time that it takes a product to move through the cell. Using the theoretical productive time available for a period (in minutes), a value-added standard cost per minute can be computed.

$$\text{Standard cost per minute} = \text{Cell conversion costs}/\text{Minutes available}$$

To obtain the conversion cost per unit, this standard cost per minute is multiplied by the actual cycle time used to produce the units during the period. By comparing the unit cost computed using the actual cycle time with the unit cost possible using the theoretical or optimal cycle time, a manager can assess the potential for improvement. Note that the more time it takes a product to move through the cell, the greater the unit product cost. With incentives to reduce product cost, this approach to product costing encourages operational managers and cell workers to find ways to decrease cycle time or increase velocity. Cornerstone 15-1 illustrates the concepts of cycle time and velocity.

[7] Other definitions of cycles are possible (e.g., a cycle's starting point could begin when the customer order is received and the finishing point when the goods are delivered to the customer). For a JIT firm, delivery to the customer is a reasonable finishing point. Another possibility for the finishing point is when the customer receives the goods. Cycle time measures the time elapsed from start to finish, regardless of how the starting and finishing points are defined.

The HOW and WHY of Calculating Cycle Time and Velocity

CORNERSTONE 15-1

Information:

Assume that a company has the following data for one of its manufacturing cells:

Theoretical velocity: 40 units per hour
Productive minutes available (per year): 1,200,000
Annual conversion costs: $4,800,000
Actual velocity: 30 units per hour

Why:

Cycle time (time/units produced) and velocity (units produced/time) measure the time it takes for a firm to respond to such things as customer orders, customer complaints, and the development of new products.

Required:

1. Calculate the actual conversion cost per unit using actual cycle time and the standard cost per minute.
2. Calculate the ideal conversion cost per unit using theoretical cycle time and the standard cost per minute. What incentive exists for managers when cycle time costing is used?
3. ***What if*** the actual velocity is 36 units per hour? What is the conversion cost per unit? What effect will this improvement have on delivery performance?

Solution:

1. Actual cycle time = 60 minutes/30 units = 2 minutes per unit
   (Notice that cycle time is the reciprocal of velocity.)
   Standard cost per minute = $4,800,000/1,200,000 = $4 per minute
   Conversion cost per unit = $4 × 2 = $8 per unit
2. Theoretical cycle time = 60 minutes/40 units = 1.5 minutes per unit
   Conversion cost per unit = $4 × 1.5 = $6 per unit
   The incentive is to reduce cycle time because it reduces the cost per unit.
3. Actual cycle time = 60 minutes/36 units = 1.67 minutes
   Conversion cost per unit = $4 × 1.67 = $6.68 per unit
   The company should be able to deliver orders more quickly and performance should improve.

Manufacturing Cycle Efficiency (MCE)

Another time-based operational measure calculates manufacturing cycle efficiency (MCE) as follows:

MCE = Processing time/(Processing time + Move time + Inspection time + Waiting time + Other non-value-added time)

where processing time is the efficient or ideal time it takes to convert materials into a finished good. The other activities and their times are viewed as wasteful, and the goal is to reduce those times to zero. If this is accomplished, the value of MCE would be 1.0. Many manufacturing companies have MCEs less than 0.05.[8] As MCE improves (moves toward 1.0), cycle time decreases. Furthermore, since the only way MCE can improve is by decreasing waste, cost reduction must also follow. Cornerstone 15-2 provides a detailed illustration of MCE.

[8] Kaplan and Norton, *The Balanced Scorecard*, 117.

CORNERSTONE 15-2

The HOW and WHY of Calculating Manufacturing Cycle Efficiency (MCE)

Information:

A company has provided the following information for one of its products for each hour of production:

Actual velocity: 100 units (per hour)
Move time: 20 minutes
Inspection time: 15 minutes
Rework time: 10 minutes

Why:

MCE measures the proportion of manufacturing cycle time attributable to value-added processing. Without waste (non-value added time), the ratio should be equal to 1.0.

Required:

1. Calculate MCE. Comment on its significance.
2. What is the theoretical cycle time? Calculate MCE using actual and theoretical cycle times.
3. ***What if*** waste is reduced by one-third? What is the new MCE? New cycle time?

Solution:

1. Process time = 60 minutes − 20 minutes −15 minutes − 10 minutes
   = 15 minutes

   MCE = Process time/(Process time + Move time + Inspection time + Rework time)
   = 15/(15 + 20 + 15 + 10)
   = 0.25

   A value of 0.25 indicates that 75 percent of the manufacturing cycle is attributable to waste.

2. Theoretical cycle time = 15 minutes/100 units = 0.15 minute
   Actual cycle time = 60 minutes/100 units = 0.60 (includes theoretical cycle time plus the waste)

   MCE = Theoretical cycle time/Actual cycle time
   = 0.15/0.60 = 0.25

3. New waste = (2/3)(20 minutes + 15 minutes + 10 minutes)
   = 30 minutes

   MCE = 15/(15 + 30) = 0.33
   (It now takes 45 minutes to produce units.)

Post-Sales Service Part of Operations Process Increasing quality, increasing efficiency, and decreasing process time are also objectives that apply to the post-sales service process. Service quality, for example, can be measured by first-pass yields where first-pass yields are defined as the percentage of customer requests resolved with a single service call. Efficiency can be measured by cost trends and

[8] Kaplan and Norton, *The Balanced Scorecard*, 117.

productivity measures. Process time can be measured by cycle time where the starting point of the cycle is defined as the receipt of a customer request and the finishing point is when the customer's problem is solved. The objectives and measures for the process perspective are summarized in Exhibit 15-3C.

4. Learning and Growth Perspective

The **learning and growth (infrastructure) perspective** defines the capabilities that an organization needs to create long-term growth and improvement. This last perspective is concerned with three major *enabling factors*: employee capabilities, information systems capabilities, and employee attitudes (motivation, empowerment, and alignment). These factors enable processes to be executed efficiently. The learning and growth perspective is the source of the capabilities that enable the accomplishment of the other three perspectives' objectives. This perspective has three major objectives: increase employee capabilities; increase motivation, empowerment, and alignment; and increase information systems capabilities.

Employee Capabilities Three core *outcome* measurements for employee capabilities are employee satisfaction ratings, employee turnover percentages, and employee productivity (e.g., revenue per employee). Examples of lead measures or performance drivers for employee capabilities include hours of training and strategic job coverage ratios (percentage of critical job requirements filled). As new processes are created, new skills are often demanded. Training and hiring are sources of these new skills. Furthermore, the percentage of the employees needed in certain key areas with the requisite skills signals the capability of the organization to meet the objectives of the other three perspectives.

Mackay Memorial Hospital in Taiwan, for example, had a specific learning and growth objective of promoting employees' ability of performing research, teaching, and innovation. Two specific performance measures for this objective were the *number of science citation index (SCI) papers* and *the number of research projects*. Thus, the more specific objectives were to increase the number of SCI papers and the number of research projects. From 2003 to 2005, the number of SCI papers increased from 132 to 1,945, and the number of research projects increased from 46 to 61.[9]

Motivation, Empowerment, and Alignment Employees must not only have the necessary skills but must also have the freedom, motivation, and initiative to use those skills effectively. The number of suggestions per employee and the number of suggestions implemented per employee are possible measures of motivation and empowerment. Suggestions per employee provide a measure of the degree of employee involvement, whereas suggestions implemented per employee signal the quality of the employee participation. The second measure also signals to employees whether or not their suggestions are being taken seriously.

Information Systems Capabilities Increasing information system capabilities means providing more accurate and timely information to employees so that they can improve processes and effectively execute new processes. Measures should be concerned with the *strategic information availability*. For example, possible measures include percentage of processes with real-time feedback capabilities and percentage of customer-facing employees with online access to customer and product information. Exhibit 15-3D summarizes the objectives and measures for the learning and growth perspective.

[9] Wen-Cheng Chang, Yu-Chi Tung, Chun-Hsiung Huang, and Ming-Chin Yang, "Performance Improvement After Implementing the Balanced Scorecard: A Large Hospital's Experience in Taiwan," *Total Quality Management* 19, no. 11 (November 2008): 1143–1154.

OBJECTIVE 3
Explain how the Balanced Scorecard links measures to strategy.

Linking Measures to Strategy

The Balanced Scorecard is a collection of critical performance measures that have some special properties. First, the performance measures are derived from a company's vision, strategy, and objectives. To link measures to a strategy, they must be derived from strategy. Second, performance measures should be chosen so that they are *balanced* between outcome and lead measures. Outcome measures such as profitability, return on investment, and market share tend to be generic and, therefore, common to most strategies and organizations. Performance drivers make things happen; consequently, lead measures are indicators of how the outcomes are going to be realized. Lead measures usually distinguish one strategy from another. Thus, lead measures are often unique to a strategy and because of this uniqueness support the objective of linking measures to strategy. Third, all scorecard measures should be linked by cause-and-effect relationships.

The Concept of a Testable Strategy with Strategic Feedback

This last requirement—that of linking through the use of cause-and-effect relationships—is the most important requirement. Cause-and-effect relationships are the means by which lead and lag measures are integrated and simultaneously serve as the mechanism for expressing and revealing the firm's strategy. Outcome measures are important because they reveal whether the strategy is being implemented successfully with the desired economic consequences. Lead measures supposedly cause the outcome. For example, if the number of defective products is decreased (a lead measure), does this result in a greater market share (an outcome or lag measure)? Does a greater market share (acting now as a lead measure), in turn, result in more revenues and profits (lag measures)? These questions reveal the vital role of cause-and-effect relationships in expressing an operational model of a strategy—a strategy that can be expressed in a testable format. In fact, a **testable strategy** can be defined as a set of linked objectives aimed at an overall goal. The testability of the strategy is achieved by restating the strategy into a set of cause-and-effect hypotheses that are expressed by a sequence of if-then statements.[10]

Perhaps the most important message associated with the cause-and-effect structure is that the viability of the strategy is testable. Strategic feedback is available that allows managers to test the reasonableness of the strategy. For example, if the number of defective products decrease, we would expect to see an increase in market share. If not, it could be due to one of two causes: (1) implementation problems or (2) an invalid strategy. First, it is possible that a *key performance indicator* such as the number of defective units did not achieve its targeted level (i.e., the reduction in the number of defective units was less than planned). In this case, the failure to produce the expected *outcomes* for other objectives (e.g., market share and revenue) could be merely an implementation problem. On the other hand, if the targeted levels of performance drivers were achieved and the expected outcomes did not materialize, then the problem could very well lie with the strategy itself. This is an example of *double-loop feedback*. **Double-loop feedback** occurs whenever managers receive information about both the *effectiveness* of strategy implementation as well as the *validity* of the assumptions underlying the strategy. In a traditional performance management system, typically, only *single-loop feedback* is provided. **Single-loop feedback** emphasizes only effectiveness of implementation. In single-loop feedback, actual results deviating from planned results are a signal to take corrective action so that the plan (strategy) can be executed as intended. The validity of the assumptions underlying the plan is usually not questioned.

Double-loop feedback is the foundation for strategic learning. In the Balanced Scorecard framework, strategic planning is dynamic—not static. Hypothesis testing makes it possible to change and adapt once it becomes clear that some parts of the

[10] Kaplan and Norton, *The Balanced Scorecard*, 149. (Kaplan and Norton describe the sequence of if-then statements only as a strategy. Calling it a testable strategy distinguishes it from the earlier, more general definition offered.)

strategy may not be viable. For example, it may be that improving quality by reducing the number of defects may not increase market share. If all other competitors are also improving quality, then the correct view may be that improving quality is needed to *maintain* market share. Increasing market share may require the company to search for some other value proposition that will be unique and innovative (e.g., offering a new product).

The **strategy map** is a useful tool that graphically illustrates the cause-and-effect relationships and connects the Balanced Scorecard strategy with an organization's operating activities. The strategy map provides a concise and pictorial representation of the firm's strategy. The linkages portrayed are for each of the firm's objectives and show how these objectives are linked for each of the four perspectives.

Strategic Alignment

OBJECTIVE ➤ 4
Describe how an organization can achieve strategic alignment.

Creating a strategy is one thing. Implementing the strategy successfully is another. For the Balanced Scorecard to be successful, the entire organization must be committed to its achievement. The Balanced Scorecard is designed to bring about organizational change. For this change to take place, employees must be fully informed of the strategy; they must share ownership for the objectives, measures, targets, and initiatives; incentives must be structured to support the strategy; and resources must be allocated to support the strategy.

Communicating the Strategy

The scorecard objectives and measures, once developed, become the means for articulating and communicating the strategy of the organization to its employees and managers. The objectives and measures also serve the purpose of aligning individual objectives and actions with organizational objectives and initiatives. Videos, newsletters, brochures, and the company's computer network are examples of media that can be used to inform employees of the strategy, objectives, and measures associated with the Balanced Scorecard. How much specific detail to communicate is certainly a relevant question. Communicating too much detail may create a potential problem with competitors. The Balanced Scorecard is a very explicit representation of the company's targeted markets and the means required for obtaining gains in these markets. This can be very sensitive information; the more employees who are aware of it, the more likely it may end up in the hands of competitors. Yet it is important that employees have a sufficient understanding of what is happening that they will accept and agree to the strategic efforts of the organization. Articulation of the Balanced Scorecard should be clear enough that individuals can see the linkage between what they do and the organization's long-term objectives. Seeing this linkage increases the likelihood that personal goals and actions are congruent with organizational goals.

Targets and Incentives

Once objectives and measures have been defined and communicated, performance expectations must be established. Performance expectations are communicated by setting targeted values for the measures associated with each objective. Managers are held accountable for the assigned responsibility by comparing the actual values of the measures with the targeted values. Finally, compensation is linked to achievement of the scorecard objectives. It is vital that the reward system be tied to all the scorecard objectives and not just to traditional financial measures. Failure to change the compensation system will encourage managers to continue their focus on short-term financial performance with little reason to pay attention to the strategic objectives of the scorecard.

Exhibit 15-4 provides an example of targets using a set of objectives and measures for a typical strategy. The relative importance that management has assigned to each perspective and objective is revealed by weights expressed as percentages. Targets are set for

Exhibit 15-4

Targets and Weighting Scheme Illustrated

Perspectives	Objectives	Measures	Targets
Financial (25%)	Increase shareholder value (25%)	Share price	50% increase
	Increase profits (25%)	Profits	100% increase
	Increase revenues (25%)	Revenues	30% increase
	Decrease process costs (25%)	Costs	20% decrease
Customer (25%)	Increase market share (20%)	Market share	25%
	Increase customer retention (30%)	Repeat orders	70%
	Improve delivery reliability (50%)	On-time percentage	100%
Internal Process (25%)	Improve cycle time (60%)	Cycle time	2 days
	Redesign process (40%)	Yes or No	Yes
Learning & Growth (25%)	Improve employee skills (100%)	Hours of training	30 hours per employee

both the long term and the short term (e.g., a three- to five-year horizon and a one-year horizon) and should be backed up with initiatives that can be undertaken to achieve them. For example, is it really possible to increase share prices by 50 percent over a three-year span? And how much increase will be targeted for the coming year? The increase is dependent on increasing revenues by 30 percent and decreasing costs by 20 percent. These changes are, in turn, dependent on other events in other perspectives. Can cycle time be reduced to two days (say, from a current level of five days)?

Structuring incentive compensation with multiple dimensions is a challenging task. Typically, weights that reflect the relative importance of the perspectives are used to determine the percentage of the bonus pool that will be assigned to each perspective. Thus, from Exhibit 15-4, we see that for this example each perspective would be assigned 25 percent of the total bonus pool. But within each category, there are usually multiple objectives and multiple measures. For example, within the customer category, there are three performance measures. How much of the 25 percent bonus pool should be assigned to each measure? Again, weights that reflect the relative importance of each objective within its category are used to make this determination. Exhibit 15-4, for example, reveals that management has decided to assign 50 percent of the customer category bonus to the on-time delivery objective, 30 percent to the customer retention objective, and 20 percent to the market share objective. Thus, of the original bonus pool, 12.5 percent is assigned to the delivery objective (0.50×0.25).

Distributing potential bonus money to the various perspectives and measures is one thing, but payment of incentive compensation is dependent on *performance*. The actual values of the measures are compared to the targeted values for a given time period. Compensation is then paid, based on the percentage achievement of each objective. However, there is one major qualification for the Balanced Scorecard framework. To ensure that proper (balanced) attention is given to all measures, no incentive compensation is paid unless each strategic measure exceeds a prespecified minimum threshold value.[11]

Firms adopting the Balanced Scorecard seem to realize the necessity of connecting their reward system to the objectives and measures of the new performance management system. A Mercer study in 1999 found that 88 percent of the responding companies reported that linking the reward system to the Balanced Scorecard was effective.[12] **Mobil**, for example, reported that it would not have had the same focus on the scorecard if there was not a link to compensation.[13] The CEO of **Cigna Property & Casualty** observed that linking compensation to the new measurement system was key to gaining acceptance of the new measurement approach.[14] In another survey by the

[11] Ibid., 219–220.

[12] William Mercer and Company, *Rewarding Employees: Balanced Scorecard Fax-Back Survey Results* (London UK, May 20, 1999).

[13] Robert S. Kaplan and David P. Norton, "Transforming the Balanced Scorecard from Performance Measurement to Strategic Management: Part II," *Accounting Horizons* (June 2001): 147–160.

[14] Ibid.

Hay Group, it was found that 13 of 15 firms studied linked compensation to the scorecard. Specifically, about 25 to 33 percent of the total compensation is affected by the Balanced Scorecard, with about 40 percent focused on the financial perspective and 20 percent assigned to each of the three remaining perspectives.[15]

Resource Allocation

Achieving strategic targets such as those envisioned in Exhibit 15-4 requires that resources be allocated to the corresponding strategic initiatives. This requires two major changes. First, an organization must decide how much of the strategic targets will be achieved for the coming year. Second, the operational budgetary process must be structured to provide the resources necessary for achievement of these short-term advances along the strategic path. If these changes are not incorporated, then it is difficult to imagine that the strategy will truly become actionable.

Summary of Learning Objectives

1. Compare and contrast activity-based and strategic-based responsibility accounting systems.

- Activity-based responsibility accounting focuses on processes, uses both operational and financial measures, employs dynamic standards, and emphasizes and supports continuous improvement.
- Strategic-based responsibility accounting expands the number of responsibility dimensions from two to four. Customer and learning and growth perspectives are added.
- Strategic-based performance measures become an integrated set of measures, linked to an organization's mission and strategy.
- Activity- and strategic-based responsibility accounting systems work best for firms operating in dynamic environments.

2. Discuss the basic features of the Balanced Scorecard.

- The Balanced Scorecard is a strategic performance management system that translates the vision and strategy of an organization into operational objectives and measures.
- Objectives and measures are developed for each of four perspectives: the financial perspective, the customer perspective, the process perspective, and the learning and growth perspective.

3. Explain how the Balanced Scorecard links measures to strategy.

- Performance measures are derived from a company's vision, strategy, and objectives.
- Performance measures are balanced between outcome and lead measures.
- All scorecard measures are linked by cause-and-effect relationships.
- The cause-and-effect relationships produce a set of testable hypotheses expressed by a sequence of if-then statements.

4. Describe how an organization can achieve strategic alignment.

- The entire organization must be committed to the Balanced Scorecard.
- Employees must be fully informed of the strategy and share ownership for the objectives, measures, targets, and initiatives.
- Incentives (e.g., compensation) must be structured to support the strategy, and resources must be allocated to support the strategy.
- Thus, alignment with the strategy expressed by the Balanced Scorecard is achieved by communication, incentives, and allocation of resources to support the strategic initiatives.

[15] Todd Manas, "Making the Balanced Scorecard Approach Payoff," *ACA Journal* 8, no. 2 (Second Quarter, 1999).

CORNERSTONES FOR CHAPTER 15

Review Problems

I. Perspectives, Measures, and Strategic Objectives

The following measures belong to one of four perspectives: financial, customer, process, or learning and growth.

a. Revenues from new products
b. On-time delivery percentage
c. Economic value added
d. Employee satisfaction
e. Cycle time
f. First-pass yields
g. Strategic job coverage ratio
h. Number of new customers
i. Unit product cost
j. Customer profitability

Required:

Classify each measure by perspective, and suggest a possible strategic objective that might be associated with the measure.

Solution:

	Perspective	*Objective*
a.	Financial	Increase number of new products
b.	Customer	Increase delivery reliability
c.	Financial	Improve asset utilization
d.	Learning and Growth	Increase motivation and alignment
e.	Process	Decrease process time
f.	Process	Increase service quality
g.	Learning and Growth	Increase employee capabilities
h.	Customer	Increase customer acquisition
i.	Financial	Decrease product cost
j.	Customer	Increase customer profitability

II. Cycle Time and Velocity, MCE

Currently, a company can produce 60 units per hour of a particular product. During this hour, move time and wait time take 30 minutes, while actual processing time is 30 minutes.

Required:

1. Calculate the current MCE.
2. Calculate the current cycle time.
3. Suppose that move time and wait time are reduced by 50 percent. What is the new velocity? The new cycle time? The new MCE?

Solution:

1. MCE = Process time/(Process time + Move time + Wait time)
   = 30 minutes/60 minutes
   = 0.50
2. Cycle time = 1/Velocity = 1/60 hour, or 1 minute
3. The time now required to produce 60 units is 45 minutes (30 minutes process time; move and wait time of 15 minutes). Thus, velocity = 60/(3/4 hour) = 80 units per hour; cycle time = 1/80 hour, or 0.75 minute. Finally, MCE = 30/(30 + 15) = 0.67.

Key Terms

Balanced Scorecard, 751
Core objectives and measures, 757
Customer perspective, 757
Customer value, 757
Cycle time (manufacturing), 760
Double-loop feedback, 764
External measures, 752
Financial measures, 752
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Internal measures, 752
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Strategy, 755
Strategy map, 765
Stretch targets, 754
Subjective measures, 752
Testable strategy, 764
Velocity, 760

Discussion Questions

1. Describe a strategic-based responsibility accounting system. How does it differ from activity-based responsibility accounting?
2. What is a Balanced Scorecard?
3. What is meant by balanced measures?
4. What is a lag measure? A lead measure?
5. What is the difference between an objective measure and a subjective measure?
6. What are stretch targets? What is their strategic purpose?
7. How does the reward system for a strategic-based system differ from the traditional approach?
8. What are the three strategic themes of the financial perspective?
9. Identify the five core objectives of the customer perspective.
10. Explain what is meant by the long wave and the short wave of value creation.
11. Define the three processes of the process value chain.
12. Identify three objectives of the learning and growth perspective.
13. What is a testable strategy?
14. What is meant by double-loop feedback?
15. Identify and explain three methods for achieving strategic alignment.

Cornerstone Exercises

OBJECTIVE 2
CORNERSTONE 15-1

Cornerstone Exercise 15-1 CYCLE TIME AND VELOCITY

Blackburn Manufacturing has the following data for one of its production departments:

Theoretical velocity: 75 units per hour
Productive minutes available per year: 2,500,000
Annual conversion costs: $15,000,000
Actual velocity: 40 units per hour

Required:

1. Calculate the actual conversion cost per unit using actual cycle time and the standard cost per minute.
2. Calculate the ideal conversion cost per unit using theoretical cycle time and the standard cost per minute. What incentive exists for managers when cycle time costing is used?
3. ***What if*** the actual velocity is 55 units per hour? What is the conversion cost per unit? What effect will this improvement have on delivery performance?

OBJECTIVE 2
CORNERSTONE 15-2

Cornerstone Exercise 15-2 MCE

Parron Company has provided the following information for one of its products for each hour of production:

Actual velocity: 80 units (per hour)
Move time: 18 minutes
Inspection time: 24 minutes
Rework time: 8 minutes

Required:

1. Calculate MCE. Comment on its significance.
2. What is the theoretical cycle time? Calculate MCE using actual and theoretical cycle times.
3. ***What if*** non-value added time is reduced by one-half? What is the new MCE? New cycle time?

Exercises

OBJECTIVE 1

Exercise 15-3 ACTIVITY-BASED RESPONSIBILITY ACCOUNTING VERSUS STRATEGIC-BASED RESPONSIBILITY ACCOUNTING

The following comment was made by the CEO of a company that recently implemented the Balanced Scorecard: "Responsibility in a strategic-based performance management system differs on the three D's: Direction, Dimension, and Diffusion."

Required:

Explain how this comment describes differences in responsibility between an activity-based and a strategic-based performance management system.

OBJECTIVE 1

Exercise 15-4 ACTIVITY-BASED RESPONSIBILITY ACCOUNTING VERSUS STRATEGIC-BASED RESPONSIBILITY ACCOUNTING

"A Balanced Scorecard expresses the complete story of a company's strategy through an integrated set of financial and nonfinancial measures that are both predictive and historical and which may be measured subjectively or objectively."

Required:

1. Using the above statement about scorecard measures, explain how scorecard measurement differs from that of an activity-based management system.

2. Explain what is meant by historical and predictive measures. Why are both types important for describing a company's strategy?

Exercise 15-5 ACTIVITY-BASED RESPONSIBILITY ACCOUNTING VERSUS STRATEGIC-BASED RESPONSIBILITY ACCOUNTING

OBJECTIVE 1 3

The Balanced Scorecard is an approach that has the objective of driving change. Performance evaluation is an integral part of this effort. Performance evaluation within the Balanced Scorecard framework is also concerned with the effectiveness and viability of the organization's strategy.

Required:

1. Describe how the Balanced Scorecard is used to drive organizational change.
2. Explain how performance evaluation is used to assess the effectiveness and viability of an organization's strategy.

Exercise 15-6 BALANCED SCORECARD, PERSPECTIVES, CLASSIFICATION OF PERFORMANCE MEASURES

OBJECTIVE 1 2

Consider the following list of scorecard measures:

a. Product profitability
b. Ratings from customer surveys
c. Number of patents pending
d. Strategic job coverage ratio
e. Revenue per employee
f. Quality costs
g. Percentage of market
h. Employee turnover percentages
i. First-pass yields
j. On-time delivery percentage
k. Percentage of revenues from new sources
l. Economic value added

Required:

Classify each measure according to the following: perspective, financial or nonfinancial, subjective or objective, and external or internal. When the perspective is process, identify which type of process: innovation, operations, or post-sales service.

Exercise 15-7 CYCLE TIME AND CONVERSION COST PER UNIT

OBJECTIVE 2

The theoretical cycle time for a product is 72 minutes per unit. The budgeted conversion costs for the manufacturing cell dedicated to the product are $6,480,000 per year. The total labour minutes available are 1,440,000. During the year, the cell was able to produce 0.5 unit of the product per hour. Suppose also that production incentives exist to minimize unit product costs.

Required:

1. Compute the theoretical conversion cost per unit.
2. Compute the applied conversion cost per minute (the amount of conversion cost actually assigned to the product).
3. Discuss how this approach to assigning conversion cost can improve delivery time performance. Explain how conversion cost acts as a performance driver for on-time deliveries.

Exercise 15-8 CYCLE TIME AND VELOCITY, MCE

OBJECTIVE 2

A manufacturing plant has the theoretical capability to produce 162,000 laptops per quarter but currently produces 60,750 units. The conversion cost per quarter is $7,290,000. There are 40,500 production hours available within the plant per quarter. In addition to the processing minutes per unit used, the production of the laptops uses 8 minutes of move time, 12 minutes of wait time, and 5 minutes of rework time. (All work is done by cell workers.)

Required:

1. Compute the theoretical and actual velocities (per hour) and the theoretical and actual cycle times (minutes per unit produced).
2. Compute the ideal and actual amounts of conversion cost assigned per laptop.
3. Calculate MCE. How does MCE relate to the conversion cost per laptop?

OBJECTIVE 2 3

Exercise 15-9 CYCLE TIME AND VELOCITY, MCE

Refer to **Exercise 15-8**. Assume that the company identifies poor plant layout as the root cause of wait time and move time.

Required:

1. Express an improvement strategy as a series of if-then statements that will reduce the conversion cost per laptop.
2. Assume that you set an MCE target of 75 percent, based on the improvement strategy described in Requirement 1. What is the expected conversion cost per unit? Explain how you can use these targets to test the viability of your quality improvement strategy.

OBJECTIVE 1 2 3

Exercise 15-10 BALANCED SCORECARD, LEAD AND LAG VARIABLES, DOUBLE-LOOP FEEDBACK

The following if-then statements were taken from a Balanced Scorecard:

a. If employee productivity increases, then process efficiency will increase.
b. If process efficiency increases, then product price can be decreased.

Required:

1. Identify the lead and lag variables, and explain your reasoning.
2. Discuss the implications of Requirement 1 for the financial and learning and growth perspectives.
3. Using the first if-then statement, explain the concept of double-loop feedback.

OBJECTIVE 3

SERVICE

Exercise 15-11 BALANCED SCORECARD

Halifax Civic Hospital developed the following series of if-then statements for its Balanced Scorecard strategy:

- If employee turnover rate decreases and employee satisfaction increases, then the quality of health care service will improve.
- If the quality of health care service improves, then operating efficiency will increase and patient satisfaction will increase.
- If operating efficiency increases, then operating costs will decrease.
- If patient satisfaction increases, then market share will increase.
- If market share increases, then revenues will increase.
- If revenues increase and costs decrease, then we will balance the budget.

Required:

1. Explain how a performance measure can act both as a lag variable and a lead indicator.
2. ***What if*** budget savings did not increase to the targeted level? Explain how this result could be attributable to either an implementation problem or an invalid strategy. What actions would likely be taken for each case?

OBJECTIVE 3

Exercise 15-12 TESTABLE STRATEGY

Consider the following quality improvement strategy as expressed by a series of if-then statements:

- If design engineers receive quality training, then they can redesign products to reduce the number of defective units.
- If the number of defective units is reduced, then customer satisfaction will increase.
- If customer satisfaction increases, then market share will increase.

- If market share increases, then sales will increase.
- If sales increase, then profits will increase.

Required:

Explain how the quality improvement strategy can be tested.

Exercise 15-13 BALANCED SCORECARD, STRATEGY TRANSLATION, DOUBLE-LOOP FEEDBACK

OBJECTIVE 2 3

Mumbai Company, an electronics firm, buys circuit boards and manually inserts various electronic devices into the printed circuit board. Mumbai sells its products to original equipment manufacturers. Profits for the past two years have been less than expected. Jocelyn Dubois, owner of Mumbai, was convinced that her firm needed to adopt a revenue growth and cost reduction strategy to increase overall profits.

After a careful review of her firm's condition, Jocelyn realized that the main obstacle for increasing revenues and reducing costs was the high defect rate of her products (a 6 percent reject rate). She was certain that revenues would grow if the defect rate was reduced dramatically. Costs would also decline as there would be fewer rejects and less rework. By decreasing the defect rate, customer satisfaction would increase, causing, in turn, an increase in market share. Jocelyn also felt that the following actions were needed to help ensure the success of the revenue growth and cost reduction strategy:

a. Improve the soldering capabilities by sending employees to an outside course.
b. Redesign the insertion process to eliminate some of the common mistakes.
c. Improve the procurement process by selecting suppliers that provide higher-quality circuit boards.

Required:

1. State the revenue growth and cost reduction strategy using a series of cause-and-effect relationships expressed as if-then statements.
2. Explain how the revenue growth strategy can be tested. In your explanation, discuss the role of lead and lag measures, targets, and double-loop feedback.

Exercise 15-14 BALANCED SCORECARD, STRATEGIC ALIGNMENT

OBJECTIVE 4

Refer to **Exercise 15-13**. Suppose that Jocelyn communicates the following weights to her CEO:

Perspective: Financial, 40%; Customer, 20%; Process, 20%; Learning and growth, 20%
Financial objectives: Profits, 50%; Revenues, 25%; Costs, 25%
Customer objectives: Customer satisfaction, 60%; Market share, 40%
Process objectives: Defects decrease, 40%; Supplier selection, 30%; Redesign process, 30%
Learning and growth objective: Training, 100%

Jocelyn next sets up a bonus pool of $100,000 and indicates that the weighting scheme just described will be used to determine the amount of potential bonus for each perspective and each objective.

Required:

1. Calculate the potential bonus for each perspective and objective.
2. Describe how Jocelyn might award actual bonuses so that her managers will be encouraged to implement the Balanced Scorecard.
3. What are some other ways that Jocelyn can encourage alignment with the company's strategic objectives (other than incentive compensation)?

Problems

OBJECTIVE 1

Problem 15-15 ACTIVITY-BASED RESPONSIBILITY ACCOUNTING VERSUS STRATEGIC-BASED RESPONSIBILITY ACCOUNTING

Carson Wei, president of Mallory Plastics, was considering a report sent to him by Emily Sorensen, vice president of operations. The report was a summary of the progress made by an activity-based management system that was implemented three years ago. Significant progress had indeed been realized. At the conclusion of the report, Emily urged Carson to consider the adoption of the Balanced Scorecard as a logical next step in the company's efforts to establish itself as a leader in its industry. Emily clearly was impressed by the Balanced Scorecard and intrigued by the possibility that the change would enhance the overall competitiveness of Mallory. She requested a meeting of the executive committee to explain the similarities and differences between the two approaches. Carson agreed to schedule the meeting but asked Emily to prepare a memo in advance, listing the most important similarities and differences between the two approaches to responsibility accounting.

Required:

Prepare the memo requested by Carson.

OBJECTIVE 2 3

Problem 15-16 SCORECARD MEASURES, STRATEGY TRANSLATION

At the end of 2011, Activo Company implemented a low-cost strategy to improve its competitive position. Its objective was to become the low-cost producer in its industry. A Balanced Scorecard was developed to guide the company toward this objective. To lower costs, Activo undertook a number of improvement activities such as JIT production, total quality management, and activity-based management. Now, after two years of operation, the president of Activo wants some assessment of the achievements. To help provide this assessment, the following information on one product has been gathered:

	2011	2013
Theoretical annual capacity*	124,800	124,800
Actual production**	104,000	117,000
Market size (in units sold)	650,000	650,000
Production hours available (20 workers)	52,000	52,000
Very satisfied customers	41,600	70,200
Actual cost per unit	$162.50	$130
Days of inventory	7.8	3.9
Number of defective units	6,500	2,600
Total worker suggestions	52	156
Hours of training	130	520
Selling price per unit	$195	$195
Number of new customers	2,600	13,000

*Amount that could be produced given the available production hours; everything produced is sold.
**Amount that was produced given the available production hours.

Required:

1. Compute the following measures for 2011 and 2013:
   a. Actual velocity and cycle time
   b. Percentage of total revenue from new customers (assume one unit per customer)
   c. Percentage of very satisfied customers (assume each customer purchases one unit)
   d. Market share
   e. Percentage change in actual product cost (for 2013 only)

f. Percentage change in days of inventory (for 2013 only)
g. Defective units as a percentage of total units produced
h. Total hours of training
i. Suggestions per production worker
j. Total revenue
k. Number of new customers

2. For the measures listed in Requirement 1, list likely strategic objectives, classified according to the four Balanced Scorecard perspectives. Assume there is one measure per objective.

Problem 15-17 IF-THEN STATEMENTS, BALANCED SCORECARD

OBJECTIVE 2 3

Refer to the data in **Problem 15-16**.

Express Activo's strategy as a series of if-then statements. What does this tell you about Balanced Scorecard measures?

Problem 15-18 STRATEGIC OBJECTIVES, SCORECARD MEASURES

OBJECTIVE 2 3

The following strategic objectives have been derived from a strategy that seeks to improve asset utilization by more careful development and use of its human assets and internal processes:

a. Increase revenue from new products.
b. Increase implementation of employee suggestions.
c. Decrease operating expenses.
d. Decrease cycle time for the development of new products.
e. Decrease rework.
f. Increase employee morale.
g. Increase customer satisfaction.
h. Increase access of key employees to customer and product information.
i. Increase customer acquisition.
j. Increase return on investment (ROI).
k. Increase employee productivity.
l. Decrease the collection period for accounts receivable.
m. Increase employee skills.

The heart of the strategy is developing the company's human resources. Management is convinced that empowering employees will lead to an increase in economic returns. Studies have shown that there is a positive relationship between employee morale and customer satisfaction. Furthermore, the more satisfied customers pay their bills more quickly. It was hypothesized that as employees became more involved and more productive their morale would improve. Thus, the strategy incorporated key objectives that would lead to an increase in productivity and involvement.

Required:

1. Classify the objectives by perspective, and suggest a measure for each objective.
2. Describe the likely causal relationships among the strategic objectives.

Problem 15-19 CYCLE TIME, CONVERSION COST PER UNIT, MCE

OBJECTIVE 2

A manufacturing cell has the theoretical capability to produce 375,000 carburetors per quarter. The conversion cost per quarter is $3,750,000. There are 125,000 production hours available within the cell per quarter.

Required:

1. Compute the theoretical velocity (per hour) and the theoretical cycle time (minutes per unit produced).
2. Compute the ideal amount of conversion cost that will be assigned per subassembly.

3. Suppose the actual time required to produce a carburetor is 35 minutes. Compute the amount of conversion cost actually assigned to each unit produced. What happens to product cost if the time to produce a unit is decreased to 25 minutes? How can a firm encourage managers to reduce cycle time? Finally, discuss how this approach to assigning conversion cost can improve delivery time.
4. Calculate MCE. How much non-value-added time is being used? How much is it costing per unit?
5. Cycle time, velocity, MCE, conversion cost per unit (theoretical conversion rate × actual conversion time), and non-value-added costs are all measures of performance for the cell process. Discuss the incentives provided by these measures.

OBJECTIVE 2 3

Problem 15-20 MCE, TESTABLE STRATEGY

Auflegger Inc. manufactures a product that experiences the following activities (and times):

	Hours
Processing (two departments)	42.0
Inspecting	2.8
Rework	7.0
Moving (three moves)	11.2
Waiting (for the second process)	33.6
Storage (before delivery to customer)	43.4

Required:

1. Compute the MCE for this product.
2. A study lists the following root causes of the inefficiencies: poor quality components from suppliers, lack of skilled workers, and plant layout. Suggest a possible cost reduction strategy, expressed as a series of if-then statements, that will reduce MCE and lower costs.
3. Is MCE a lag or a lead measure? If and when MCE acts as a lag measure, what lead measures would affect it?

OBJECTIVE 3

Problem 15-21 CYCLE TIME, VELOCITY, PRODUCT COSTING

Morrison Inc. has a JIT system in place. Each manufacturing cell is dedicated to the production of a single product or major subassembly. One cell, dedicated to the production of small four wheelers, has four operations: machining, finishing, assembly, and qualifying (testing). The machining process is automated, using computers. In this process, the model's frame and engine are constructed. In finishing, the frame is sandblasted, buffed, and painted. In assembly, the frame and engine are assembled. Finally, each model is tested to ensure operational capability.

For the coming year, the four-wheeler cell has the following budgeted costs and cell time (both at theoretical capacity):

Budgeted conversion costs	$15,500,000
Budgeted materials	$18,600,000
Cell time	24,800 hours
Theoretical output	18,600 models

During the year, the following actual results were obtained:

Actual conversion costs	$15,500,000
Actual materials	$16,120,000
Actual cell time	24,800 hours
Actual output	15,500 models

Required:

1. Compute the velocity (number of models per hour) that the cell can theoretically achieve. Now, compute the theoretical cycle time (number of hours or minutes per model) that it takes to produce one model.

2. Compute the actual velocity and the actual cycle time.
3. Compute MCE. Comment on the efficiency of the operation.
4. Compute the budgeted conversion cost per minute. Using this rate, compute the conversion cost per model if theoretical output is achieved. Using this measure, compute the conversion cost per model for actual output. Does this product costing approach provide an incentive for the cell manager to reduce cycle time? Explain.

Problem 15-22 BALANCED SCORECARD, NON-VALUE-ADDED ACTIVITIES, STRATEGY TRANSLATION, KAIZEN COSTING

OBJECTIVE ➤ 1 2 3 4

At the beginning of the last quarter of 2011, Blind River Ltd., a consumer products firm, hired Brittiny (Brit) Compton to take over one of its divisions. The division manufactured small home appliances and was struggling to survive in a very competitive market. Brit immediately requested a projected income statement for 2011. In response, the controller provided the following statement:

Sales	$25,000,000
Variable expenses	20,000,000
Contribution margin	5,000,000
Fixed expenses	6,000,000
Projected loss	$ (1,000,000)

After some investigation, Brit soon realized that the products being produced had a serious problem with quality. She once again requested a special study by the controller's office to supply a report on the level of quality costs. By the middle of November, Brit received the following report from the controller:

Inspection costs, finished product	$ 400,000
Rework costs	2,000,000
Scrapped units	600,000
Warranty costs	3,000,000
Sales returns (quality-related)	1,000,000
Customer complaint department	500,000
Total estimated quality costs	$7,500,000

Brit was surprised at the level of quality costs. They represented 30 percent of sales, which was certainly excessive. She knew that the division had to produce high-quality products to survive. The number of defective units produced needed to be reduced dramatically. Thus, Brit decided to pursue a quality-driven turnaround strategy. Revenue growth and cost reduction could both be achieved if quality could be improved. By growing revenues and decreasing costs, profitability could be increased.

After meeting with the managers of production, marketing, purchasing, and human resources, Brit made the following decisions, effective immediately (end of November 2011):

a. More will be invested in employee training. Workers will be trained to detect quality problems and empowered to make improvements. Workers will be allowed a bonus of 10 percent of any cost savings produced by their suggested improvements.
b. Two design engineers will be hired immediately, with expectations of hiring one or two more within a year. These engineers will be in charge of redesigning processes and products with the objective of improving quality. They will also be given the responsibility of working with selected suppliers to help improve the quality of their products and processes. Design engineers are considered a strategic necessity.

c. Implement a new process: evaluation and selection of suppliers. This new process has the objective of selecting a group of suppliers that are willing and capable of providing nondefective components.
d. Effective immediately, the division will begin inspecting purchased components. According to production, many of the quality problems are caused by defective components purchased from outside suppliers. Incoming inspection is viewed as a transitional activity. Once the division has developed a group of suppliers capable of delivering nondefective components, this activity will be eliminated.
e. The goal is to produce products with a defect rate less than 0.10 percent within three years. By reducing the defect rate to this level, marketing is confident that market share will increase by at least 50 percent (as a consequence of increased customer satisfaction). Products with better quality will help establish an improved product image and reputation, allowing the division to capture new customers and increase market share.
f. Accounting will be given the task of installing a quality information reporting system. Daily reports on operational quality data (e.g., percentage of defective units), weekly updates of trend graphs (posted throughout the division), and quarterly cost reports are the types of information required.
g. To help direct the improvements in quality activities, kaizen costing is to be implemented. For example, for the year 2012, a kaizen standard of 6 percent of the selling price per unit will be set for rework costs, a 25 percent reduction from the current actual cost.

To ensure that the quality improvements are directed and translated into concrete financial outcomes, Brit has also begun to implement a Balanced Scorecard for the division. By the end of 2012, progress is being made. Sales have increased to $26,000,000, and the kaizen improvements are meeting or beating expectations. For example, rework costs have dropped to $1,500,000.

At the end of 2013, two years after the turnaround quality strategy was implemented, Brit receives the following quality cost report:

Quality training	$ 500,000
Supplier evaluation	230,000
Incoming inspection costs	400,000
Inspection costs, finished product	300,000
Rework costs	1,000,000
Scrapped units	200,000
Warranty costs	750,000
Sales returns (quality-related)	435,000
Customer complaint department	325,000
Total estimated quality costs	$4,140,000

Brit also receives an income statement for 2013:

Sales	$30,000,000
Variable expenses	22,000,000
Contribution margin	8,000,000
Fixed expenses	5,800,000
Income from operations	$ 2,200,000

Brit is pleased with the outcomes. Revenues have grown, and costs have been reduced by at least as much as she had projected for the two-year period. Growth next year should be even greater as she is beginning to observe a favourable effect from the higher-quality products. Also, further quality cost reductions should materialize as incoming inspections are showing much higher-quality purchased components.

Required:

1. Identify the strategic objectives, classified by the Balanced Scorecard perspectives. Next, suggest measures for each objective.
2. Using the results from Requirement 1, describe Brit's strategy using a series of if-then statements.
3. Explain how you would evaluate the success of the quality-driven turnaround strategy. What additional information would you like to have for this evaluation?
4. Explain why Brit felt that the Balanced Scorecard would increase the likelihood that the turnaround strategy would actually produce good financial outcomes.
5. Advise Brit on how to encourage her employees to align their actions and behaviour with the turnaround strategy.

CMA Problem

CMA Problem 15-1 THE BALANCED SCORECARD*

Aegean Inc. is pursuing a number of strategic objectives under an overall strategy to become a low-cost producer. To this end, it applies a balanced scorecard perspective. To succeed in this strategy, Aegean has undertaken a number of initiatives including total quality management, activity-based costing, and JIT. By the end of the year 2013, the new strategy had been in place for two full years, and it was felt an assessment was necessary to find out how well the new strategy had worked.

The data below were gathered to facilitate this assessment.

	2012	2013
Theoretical maximum capacity (units)	96,000	96,000
Actual production (units)	76,000	88,000
Production hours available (20 employees)	40,000	40,000
Post-purchase costs per unit	$ 20	$ 10
Kilograms of materials used	100,000	100,000
Kilograms of scrap	10,000	8,000
Selling price per unit	$ 150	$ 140
Actual cost per unit	$ 125	$ 100
Days in inventory	6	3
Number of new customers	2,000	8,000
Number of defective units	4,500	2,000
Suggestions per employee	2	6
Hours of training	100	400

Required:

1. Compute the following for both years 2012 and 2013:
   a. Theoretical velocity and cycle time
   b. Actual velocity and cycle time
   c. Labour productivity
   d. Scrap as a percentage of materials used
   e. Percentage change in post-purchase costs for 2013
   f. Percentage change in actual product costs for 2013
   g. Percentage change in days of inventory for 2013
   h. Percentage of defective units in terms of total units produced
   i. New customers metric
   j. Hours of training metric
   k. Total employee suggestions

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2. Classify the above data according to balanced scorecard perspectives (Financial, Customer, Process, Learning and Growth) indicating each metric as lead or lag variable. Then evaluate the overall strategy success of Aegean. *(Adapted from CMA Ontario)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

After studying this chapter, you should be able to:

1. Define quality, describe the four types of quality costs, and discuss the approaches used for quality cost measurement.
2. Prepare a quality cost report, and explain its use.
3. Explain why quality cost information is needed and how it is used.
4. Describe and prepare three different types of quality performance reports.
5. Discuss how environmental costs can be measured, reported, and reduced.
6. Show how environmental costs can be assigned to products and processes.

CHAPTER 16

Quality and Environmental Cost Management

There are numerous quality- and environmental-related activities, all of which consume resources that determine the level of quality and environmental costs incurred by a firm. Inspecting or testing parts, for example, is a quality appraisal activity that has the objective of detecting bad products, whereas contamination tests are designed to measure the level of pollution. Detecting bad products and correcting them before they are sent to customers is usually less expensive than letting them be acquired by customers. Similarly, preventing contamination and waste from entering the environment is also usually less expensive. The objective of quality and environmental cost management is to find ways to minimize total quality and environmental costs. Interestingly, there are remarkable similarities between the two approaches. Quality cost management will first be explored, followed by environmental cost management.

Competitive forces are requiring firms to pay increasing attention to quality. Customers are demanding higher-quality products and services. Improving quality may actually be the key to survival for many firms. Improving process quality and the quality of products and services is a fundamental strategic objective that is part of any well-designed Balanced Scorecard. If quality is improved, then customer satisfaction

increases; if customer satisfaction increases, then market share will increase; and if market share increases, then revenues will increase; moreover, if quality improves, then operating costs will also decrease. Thus, improving quality can increase market share and sales, while simultaneously decreasing costs. The overall effect enhances a firm's financial and competitive position.

Improving quality can increase firm value because it increases a firm's profitability. Improving quality can increase profitability in at least two ways: (1) by increasing customer demand and (2) by decreasing the costs of providing goods and services.

Over the past few years, major companies but also other organizations have made significant strides in improving quality. Even so, much remains to be done. The costs of quality can be substantial and a source of significant savings. According to some experts, most companies, if they properly evaluate their costs of quality, will find that they are between 15 and 25 percent of sales.[1] Most experts tend to agree that quality costs range between 5 and 30 percent of sales.[2] Yet, quality experts indicate that the optimal quality level should be about 2 to 4 percent of sales. This difference between actual and optimal figures represents a veritable gold mine of opportunity. Improving quality can produce significant improvements in profitability.

In 2003, **Caterpillar Financial Services Corporation U.S. (CFSC)** won a Malcolm Baldrige National Quality Award. The Malcolm Baldrige Quality award recognizes companies that excel in quality management and achievement. CFSC improved its quality and increased its contributions to Caterpillar Inc.'s total earnings from 5.6 percent to more than 25 percent.[3] CFSC's efforts to improve quality produced significant after-tax savings, increased customer satisfaction levels (exceeding industry benchmarks), and improved the overall work environment (80 percent of employees indicated that they would recommend CFSC as a place to work, exceeding the national norm of 55 percent).

As companies implement quality improvement programs, a need arises to monitor and report on the progress of these programs. Managers need to know what quality costs are and how they are changing over time. Reporting and measuring quality performance is absolutely essential to the success of an ongoing quality improvement program. A fundamental prerequisite for this reporting is measuring the costs of quality. But to measure those costs, an operational definition of quality is needed.

OBJECTIVE 1

Define quality, describe the four types of quality costs, and discuss the approaches used for quality cost measurement.

Quality Defined

Operationally, a **quality product or service** is one that meets or exceeds customer expectations. In effect, quality is customer satisfaction. But what is meant by "customer expectations"? Customers can be concerned with such product attributes as reliability, durability, fitness for use, and conformance to specifications. Although many important attributes can affect customer satisfaction, the quality attributes that are measurable tend to receive more emphasis. Conformance, in particular, is strongly emphasized. In fact, many quality experts believe that "**quality of conformance**" is the best operational definition. There is some logic to this position. Product specifications should explicitly consider such things as reliability, durability, and fitness for use. Implicitly, a conforming product is reliable, durable, fit for use, and performs well. The product should be produced as the design specifies it; specifications should

[1] M. J. Harry and R. Schroeder, *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations* (New York: Doubleday, Random House, 2000).

[2] G. Giakatis, T. Enkawa, and K. Washitani, "Hidden Quality Costs and the Distinction between Quality Cost and Quality Loss," *Total Quality Management*, 12, 2 (2001): 179–180.

[3] S. M. Paton, "Quality Conversation with James S. Beard," *Quality Digest*, (September 2004), http://www.qualitydigest.com/sept04/articles/07_article.shtml.

be met. Conformance is the basis for defining what is meant by a nonconforming, or *defective*, product.

A **defective product** is one that does not conform to specifications. **Zero defects** means that all products conform to specifications. But what is meant by "conforming to specifications"? Traditional conformance defines an acceptable range of values for each specification or quality characteristic. A target value is defined, and upper and lower limits are set that describe acceptable product variation for a given quality characteristic. Any unit that falls within the limits is deemed nondefective. For example, the targeted specification for a machined part may be a drilled hole that is two cm in diameter, and any part that is within 3 percent of the target is acceptable. On the other hand, the *robust quality view* of conformance emphasizes exactness of conformance. **Robustness** means exact conformance to the target value (no tolerance allowed). There is no range in which variation is acceptable. A nondefective machine part in the robust setting would be one that has a drilled hole that measures exactly two cm. Since evidence exists that product variation can be costly, the robust quality definition of conformance is superior to the traditional definition.

Costs of Quality

Quality-linked activities are those activities performed because poor quality may or does exist. The costs of performing these activities are referred to as costs of quality. There are four categories of quality costs: (1) prevention costs, (2) appraisal costs, (3) internal failure costs, and (4) external failure costs.

Prevention costs are incurred to prevent poor quality in the products or services being produced. As prevention costs increase, we would expect the costs of failure to decrease. Examples of prevention costs are quality engineering, quality training programs, quality planning, quality reporting, supplier evaluation and selection, quality audits, quality circles, field trials, and design reviews.

Appraisal costs are incurred to determine whether products and services are conforming to their requirements or customer needs. Examples include inspecting and testing materials, packaging inspection, supervising appraisal activities, product acceptance, process acceptance, measurement (inspection and test) equipment, and outside endorsements. Two of these terms require further explanation.

Product acceptance involves sampling from batches of finished goods to determine whether they meet an acceptable quality level; if so, the goods are accepted. *Process acceptance* involves sampling goods while in process to see if the process is in control and producing nondefective goods; if not, the process is shut down until corrective action can be taken. The main objective of the appraisal function is to prevent nonconforming goods from being shipped to customers.

Internal failure costs are incurred because products and services do not conform to specifications or customer needs. This nonconformance is detected prior to the product being shipped or the service being delivered to outside parties. These are the failures detected by appraisal activities. Examples of internal failure costs are scrap, rework, downtime (due to defects), reinspection, retesting, and design changes. These costs disappear if no defects exist.

External failure costs are incurred because products and services fail to conform to requirements or satisfy customer needs after being delivered to customers. Of all the costs of quality, this category can be the most devastating. Costs of recalls, for example, can run into the hundreds of millions. Other examples include lost sales because of poor product performance, returns and allowances because of poor quality, warranties, repair, product liability, customer dissatisfaction, lost market share, and complaint adjustment. External failure costs, like internal failure costs, disappear if no defects exist.

Costs of quality are the costs that exist because poor quality may or does exist. This definition implies that quality costs are associated with two subcategories of quality-related activities: *control activities* and *failure activities*. **Control activities** are

performed by an organization to prevent or detect poor quality (because poor quality may exist). Thus, control activities are made up of prevention and appraisal activities. **Control costs** are the costs of performing control activities. **Failure activities** are performed by an organization or its customers in response to poor quality (poor quality does exist). If the response to poor quality occurs before delivery of a bad (nonconforming, unreliable, not durable, and so on) product to a customer, the activities are classified as internal failure activities; otherwise, they are classified as external failure activities. **Failure costs** are the costs incurred by an organization because failure activities are performed. Notice that the definitions of failure activities and failure costs imply that customer response to poor quality can impose costs on an organization.

Exhibit 16-1 summarizes the four quality cost categories and lists specific examples of costs. Each of the costs could have been expressed as the cost of quality-related activities such as the cost of certifying vendors, inspecting incoming materials, adjusting complaints, and so on.

Quality Cost Measurement

Quality costs can also be classified as *observable* or *hidden*. **Observable quality costs** are those that are available from an organization's accounting records. **Hidden quality costs** are opportunity costs resulting from poor quality. (Opportunity costs are not usually recognized in accounting records.) Consider, for example, all the examples of quality costs listed in Exhibit 16-1. With the exception of lost sales, customer dissatisfaction, and lost market share, all the quality costs are observable and should be available from the accounting records. Note also that the hidden costs are all in the external failure category. These hidden quality costs can be significant and should be estimated. Although estimating hidden quality costs is not easy, three methods have been suggested: (1) the multiplier method, (2) the market research method, and (3) the Taguchi quality loss function.

Exhibit 16-1

Examples of Quality Costs by Category

Prevention Costs	Appraisal (Detection) Costs
Quality engineering	Inspection of materials
Quality training	Packaging inspection
Recruiting	Product acceptance
Quality audits	Process acceptance
Design reviews	Field testing
Quality circles	Continuing supplier verification
Marketing research	
Prototype inspection	
Vendor certification	
Internal Failure Costs	**External Failure Costs**
Scrap	Lost sales (performance-related)
Rework	Lost market share
Downtime (defect-related)	Customer dissatisfaction
Reinspection	Ill will
Retesting	Returns/allowances
Design changes	Recalls
Repairs	Warranties
	Discounts due to defects
	Product liability
	Complaint adjustment

The Multiplier Method The multiplier method assumes that the total failure cost is simply some multiple of measured failure costs:

$$\text{Total external failure cost} = k(\text{Measured external failure costs})$$

where k is the multiplier effect. The value of k is based on experience. For example, **Westinghouse Electric** reports a value of k between 3 and 4.[4] Thus, if the measured external failure costs are \$3 million, the actual external failure costs are between \$9 million and \$12 million. Sampling and surveying are common methods used by companies to determine the value of the multiplier.[5] Including hidden costs in assessing the amount of external failure costs allows management to more accurately determine the level of resource spending for prevention and appraisal activities. Specifically, with an increase in failure costs, we would expect management to increase its investment in control costs.

The Market Research Method Formal market research methods are used to assess the effect of poor quality on sales and market share. Customer surveys and interviews with members of a company's sales force can provide significant insights into the magnitude of a company's hidden costs. Market research results can be used to project future profit losses attributable to poor quality.

The Taguchi Quality Loss Function The traditional zero defects definition assumes that hidden quality costs exist only for units that fall outside the upper and lower specification limits. The **Taguchi loss function** assumes that any variation from the target value of a quality characteristic causes hidden quality costs. Furthermore, the hidden quality costs increase quadratically as the actual value deviates from the target value. The Taguchi quality loss function, illustrated in Exhibit 16-2, can be described by the following equation:

$$L(A) = k(A - T)^2$$

where

k = A proportionality constant dependent upon the organization's external failure cost structure
A = Actual value of quality characteristic
T = Target value of quality characteristic
L = Quality loss

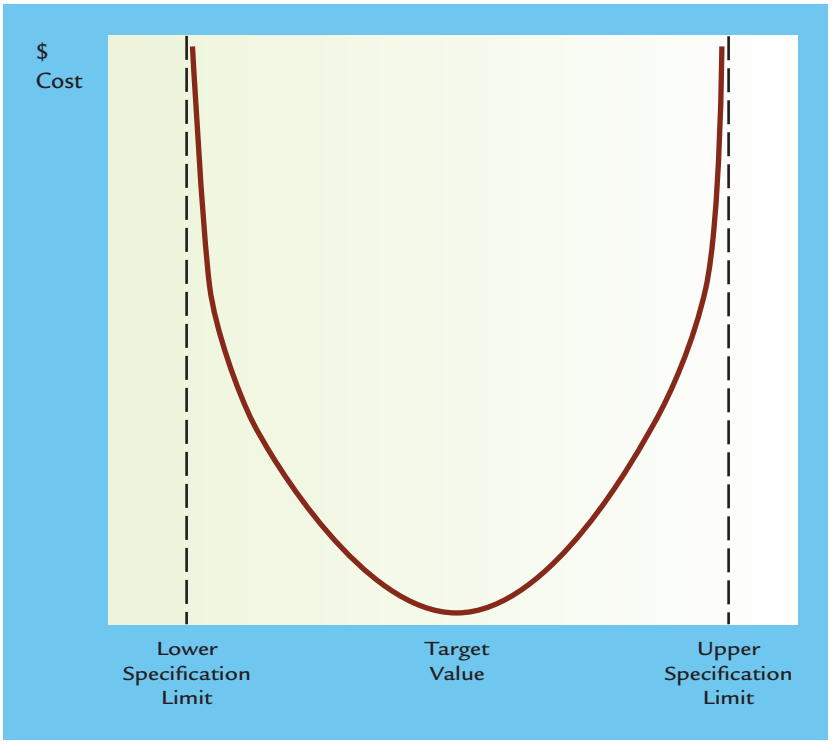
Exhibit 16-2 demonstrates that the quality cost is zero at the target value and increases symmetrically, at an increasing rate, as the actual value varies from the target value. Assume, for example, that a company produces watches and the quality characteristic is accuracy (as measured by how much time is gained or lost in three months). Assume $K = \$2$ and $T = 0$ minutes. Exhibit 16-3 illustrates the computation of the quality loss for four units. Notice that the cost quadruples when the deviation from target doubles (Units 2 and 3). Notice also that the average deviation squared and the average loss per unit can be computed. These averages can be used to compute the total expected hidden quality costs for a product. If, for example, the total units produced are 5,000 and the average squared deviation is 7.5, then the expected cost per unit is \$15 ($7.5 \times \$2$) and the total expected loss for the 5,000 units would be \$75,000 ($\$15 \times 5{,}000$).

[4] T. L. Albright and P. R. Roth, "The Measurement of Quality Costs: An Alternative Paradigm," *Accounting Horizons* (June 1992): 15–27.

[5] V. Sower, "Estimating External Failure Costs: A Key Difficulty in COQ Systems," *Quality Congress. ASQ's Annual Quality Congress Proceedings,* 58 (2004): 547–552.

Exhibit 16-2

The Taguchi Quality Loss Function



To apply the Taguchi loss function, k must be estimated. The value for k is computed by dividing the estimated cost at one of the specification limits by the squared deviation of the limit from the target value:

$$k = c/d^2$$

where

c = Loss at the lower or upper specification limit
d = Distance of limit from target value

This means that we still must estimate the loss for a given deviation from the target value. The first two methods, the multiplier method or the market research method, may be used to help in this estimation (a one-time assessment need). Once k is known, the hidden quality costs can be estimated for any level of variation from the target value.

Exhibit 16-3

Quality Loss Computation Illustrated

Unit No.	Time Gained (Lost) (A)	$A - T$	$(A - T)^2$	$k(A - T)^2$
1	−1	−1	1	$ 2.00
2	2	2	4	8.00
3	4	4	16	32.00
4	−3	−3	9	18.00
			30	$60.00
Units			÷ 4	÷ 4
Average			7.5	$15.00

Reporting Quality Costs

OBJECTIVE 2
Prepare a quality cost report, and explain its use.

A quality cost reporting system is essential to an organization serious about improving and controlling quality costs. The first and simplest step in creating such a system is assessing current actual quality costs. A detailed listing of actual quality costs by category can provide two important insights. First, it reveals the magnitude of the quality costs in each category, allowing managers to assess their financial impact. Second, it shows the distribution of quality costs by category, allowing managers to assess the relative importance of each category. Cornerstone 16-1 illustrates a quality cost report for Chesser Company.

The financial significance of quality costs can be assessed more easily by expressing these costs as a percentage of actual sales. The quality cost report in Cornerstone 16-1, for example, reports Chesser Company's quality costs as representing 20 percent of sales for fiscal 2013. Given the rule of thumb that quality costs should be no more than about 2.5 percent, Chesser Company has ample opportunity to improve profits by decreasing quality costs by improving quality.

Cornerstone 16-1 suggests that Chesser Company needs to embark on a serious quality improvement program to reduce its quality costs. But by how much should quality costs be reduced? Is there an optimal level of costs that a manager should be striving to achieve?

Zero-Defects Model and Robust Quality View

The original or traditional zero-defects model makes the claim that it is cost beneficial to reduce *nonconforming units* to zero. In the mid-1980s, the zero-defects model was taken one step further by the robust quality model, which made the definition of a defective or nonconforming unit much tighter. According to the robust view, a loss is experienced from producing products that vary from a target value; the greater the distance from the target value, the greater the loss. In other words, variation from the ideal is costly, and specification limits serve no useful purpose and, in fact, may be deceptive. The zero-defects model understates the quality costs and, thus, the potential for savings from even greater efforts to improve quality. Therefore, the robust quality model tightened the definition of a defective unit, refined our view of quality costs, and intensified the quality race.

For firms operating in an intensely competitive environment, improving quality is a competitive necessity. If the robust quality view is correct, then firms can capitalize on it, decreasing the number of defective units (robustly defined as zero tolerance) while simultaneously decreasing their total quality costs. Essentially, as firms increase their prevention and appraisal costs and reduce their failure costs, they discover that they can then cut back on their prevention and appraisal costs. Notice that failure costs can be reduced to zero according to this model and that control costs are finite at the zero-defect point.

The strategy to reduce quality costs recommended by the American Society for Quality Control, in part, states:

> *The strategy for reducing quality costs is quite simple: (1) take direct attack on failure costs in an attempt to drive them to zero; (2) invest in the "right" prevention activities to bring about improvement; (3) reduce appraisal costs according to results achieved; and, (4) continuously evaluate and redirect prevention efforts to gain further improvement. This strategy is based on the premise that:*
>
> - *For each failure there is a* root cause.
> - *Causes are* preventable.
> - *Prevention is always* cheaper.[6]

This ability to reduce total quality costs dramatically in all categories is borne out by real-world experiences. Westinghouse Electric, for example, found that its profits

[6] Jack Campanella, ed., *Principles of Quality Costs* (Milwaukee: ASQC Quality Press, 1990): 12.

CORNERSTONE 16-1

The HOW and WHY of Preparing a Quality Cost Report

Information:

Chesser Company had total sales of $5,000,000 for fiscal year ended March 31, 2013. Chesser's costs of quality-related activities are as follows:

Warranty	$250,000
Scrap	150,000
Reliability engineering	65,000
Rework	100,000
Quality training	10,000
Process acceptance	70,000
Materials inspection	30,000
Customer complaints	325,000

Why:

A quality cost report reveals the magnitude of the quality costs by category, and it also shows the relative distribution of these costs. The relative distribution allows the manager to assess the importance of the various categories and to determine where quality improvement emphasis is needed.

Required:

1. Prepare a quality cost report, classifying costs by category and expressing each category as a percentage of sales. What message does the cost report provide?
2. Prepare a bar graph and pie chart that illustrates each category's contribution to total quality costs. Comment on the significance of the distribution.
3. ***What if*** five years from now, quality costs are 2.5 percent of sales, with control costs being 80 percent of the total quality costs? What would your conclusion be?

Solution:

1.

Quality Cost Report Chesser Company
For the Year Ended March 31, 2013

	Quality Costs		Percentage of Sales[a]
Prevention costs:			
Quality training	$ 10,000		
Reliability engineering	65,000	$ 75,000	1.50%
Appraisal costs:			
Materials inspection	30,000		
Process acceptance	70,000	100,000	2.00
Internal failure costs:			
Scrap	150,000		
Rework	100,000	250,000	5.00
External failure costs:			
Warranty	250,000		
Customer complaints	325,000	575,000	11.50
Total quality costs		$1,000,000	20.00%[b]

[a] Actual sales of $5,000,000.
[b] $1,000,000/$5,000,000 = 20 percent

The report clearly indicates that quality costs are too high as 20 percent of sales are much greater than the desired 2 to 4 percent of sales that prevails for companies with good quality performance.

2. See Exhibit 16-4. The graphs reveal that failure costs are approximately 82 percent of the total quality costs, suggesting that Chesser needs to invest more in control activities to drive down failure costs.
3. First, assuming that the reduction in quality costs is due to quality improvements, the 2.5 percent level reveals that the company is producing at a very high quality level. In practical terms, if quality costs are in the 2 to 4 percent range with virtually no failure costs (0.5 percent of sales in this case), then the company has effectively and practically achieved a zero-defects state.

CORNERSTONE 16-1 *(continued)*

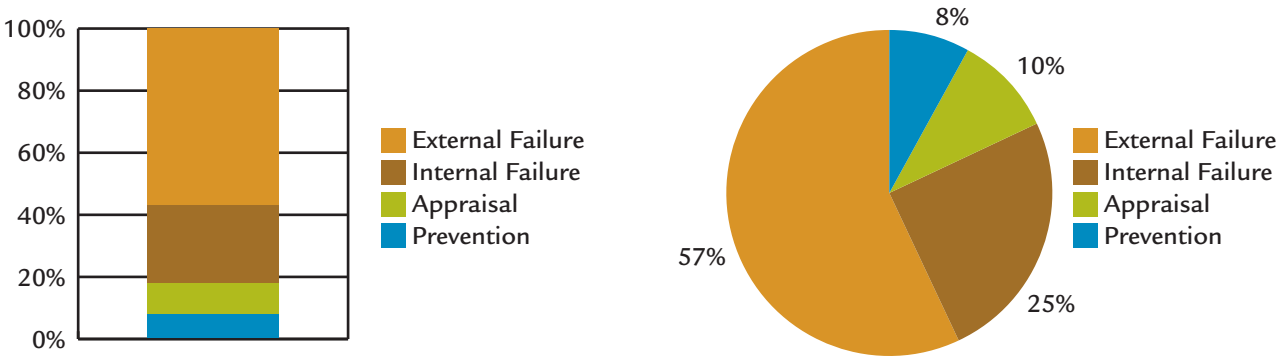
continued to improve until its control costs accounted for about 70 to 80 percent of total quality costs.[7] Based on this experience, we know that it is possible to reduce total quality costs significantly—in all categories—and that the process radically alters the relative distribution of the quality cost categories.

The Role of Activity-Based Cost Management

Activity-based costing (ABC) can be used to calculate the quality costs per unit of a firm's products. Once an ABC system is in place, the only requirement is to identify those activities that are quality related, such as inspection, rework, and warranty work. Assume, for example, that the cost of the rework activity is $250,000. Now, assume that a company produces 10,000 units each of two products: a regular model and a deluxe model. The number of units reworked is 1,000 for the regular model and 4,000 for the deluxe model (units reworked is the activity driver). The activity rate is $50 per reworked unit ($250,000/5,000), and the rework costs (an internal failure cost) assigned to each product are $50,000 and $200,000 for the regular model and the deluxe model, respectively. This provides a signal that the deluxe model is of lower quality than the regular model. Thus, ABC can be used as a means to identify

Exhibit 16-4

Quality Cost Categories: Relative Contribution Graphs



[7] These factual observations are based on those reported by Lawrence Carr and Thomas Tyson, "Planning Quality Cost Expenditures," *Management Accounting* (August 1995).

cost objects with quality problems, such as low-quality products, low-quality processes, and low-quality suppliers. This can then allow more focused management of quality costs.

Activity-based management (ABM) is also useful. ABM classifies activities as value-added and non-value-added and keeps only those that add value. This principle can be applied to quality-related activities. Appraisal and failure activities and their associated costs are non-value-added and should be eliminated (eventually). Prevention activities—performed efficiently—can be classified as value-added and should be retained. A company may be tracking all four categories of quality costs, but choose not to report prevention costs as part of the final cost of quality figures. This may be done to prevent managers from reducing quality costs by cutting prevention activities. Prevention activities pay off as they typically reduce external defects in multiples of the prevention costs.

Root causes (cost drivers) can also be identified, especially for failure activities, and used to help managers understand what is causing the costs of the activities. This information can then be used to select ways of reducing quality costs to an appropriate level. In effect, activity-based management supports the robust zero-defect view of quality costs. There is no optimal trade-off between control and failure costs; the latter are non-value-added costs and should be reduced to zero. Some control activities are non-value-added and should be eliminated. Other control activities are value-added but may be performed inefficiently, and the costs caused by the inefficiency are non-value-added. Thus, costs for these categories may also be reduced to lower levels.

OBJECTIVE 3
Explain why quality cost information is needed and how it is used.

Quality Cost Information and Decision Making

Reporting quality costs can improve managerial planning, control, and decision making. For example, if a company wants to implement a process re-engineering program to improve the quality of its products, it will need to assess the following: current quality costs by item and by category, the additional costs associated with the program, and the projected savings by item and by category. *When* the costs and savings will occur must also be projected. Then, a capital budgeting analysis can be produced to determine the merits of the proposed program. If the outcome is favourable and the program is initiated, then it becomes important to monitor the program through performance reporting.

Using quality cost information to implement and monitor the effectiveness of quality programs is only one use of a quality cost system. Other important uses can also be identified. Quality cost information is an important input to management decision making. It is also important to outside parties as they assess the quality of the company, through programs such as ISO 9000.

Managers need quality cost information in a number of decision-making contexts. Two of these contexts are strategic pricing and cost-volume-profit analysis.

Strategic Pricing

Consider AMD Inc., which produces electronic measurement devices. Market share for the company's low-level electronic measurement instruments had been steadily dropping. Linda Werther, marketing manager, identified price as the major problem. She knew that Japanese firms produced and sold the low-level instruments for less than AMD could. If AMD reduced its price to that of the competition, the new price would be below cost. Yet if something were not done, the Japanese firms would continue to expand their market share. One possibility was simply to drop the low-level line and concentrate on instruments in the medium and high-level categories. Linda knew, however, that this was a short-term solution, since soon the same Japanese firms would be competing at the higher levels. A brief income statement for the low-level instruments is as follows:

Revenues (1,000,000 @ $20)	$ 20,000,000
Cost of goods sold	(15,000,000)
Operating expenses	(3,000,000)
Product-line income	$ 2,000,000

Linda strongly believed that a 15 percent price decrease would restore the instrument line's market share and profitability to its former levels. One possibility was the implementation of total quality management. Her first action was to request information on the quality costs for the lower-level instruments. AMD's controller, Ahmet Sayed, admitted that the costs were not tracked separately. For example, the cost of scrap was buried in the work-in-process inventory account. He did promise, however, to estimate some of the costs. Data from his report for the low-level instruments are as follows:

Quality costs (estimated):	
Inspection of materials	$ 200,000
Scrap	800,000
Rejects	500,000
Rework	400,000
Product inspection	300,000
Warranty work	1,000,000
Total estimate	$3,200,000

Upon receiving the report, Linda, Ahmet, and Joe Luccheti, manager of the Quality Control Department, met to determine possible ways of reducing quality costs for the low-level line. Joe was confident that the quality costs could be reduced by 50 percent within 18 months. He had already begun planning the implementation of a new quality program. Linda calculated that a 50 percent reduction in the quality costs associated with the low-level instruments would reduce costs by about $1.60 per unit ($1,600,000/1,000,000)—which would make up slightly more than half of the $3 reduction in selling price that would be needed (the reduction is 15 percent of $20). Based on this outcome, Linda decided to implement the price reduction in three phases: a $1 reduction immediately, a $1 reduction in six months, and the final reduction of $1 in 12 months. This phased reduction would likely prevent any further erosion of market share and would start increasing market share sometime in the second phase. By phasing in the price reductions, the Quality Control Department would have time to reduce costs so that any big losses could be avoided.

The AMD Inc. example illustrates that both quality cost information and the implementation of a total quality control program contributed to a significant strategic decision. It also illustrates that improving quality was not a panacea. The reductions were not as large as needed to bear the full price reduction. Other productivity gains will be needed to ensure the long-range viability of the product line. Implementing JIT manufacturing, for example, might reduce inventories and decrease costs of materials handling and maintenance.

Cost-Volume-Profit Analysis and Strategic Design Decisions

Traditionally, cost-volume-profit analysis relies on the analysis of fixed and variable costs in conjunction with cost. Terry Foster, the marketing manager, and Sharon Fox, the design engineer, discovered shortcomings in the traditional analysis when they proposed a new product. They had been certain that a proposal for the new product was going to be approved. Instead, they received the following report from the controller's office:

Report: New Product Analysis, Project 675

Projected sales potential: 44,000 units
Production capacity: 45,000 units
Unit selling price: $60
Unit variable costs: $40

Report: New Product Analysis, Project 675

Fixed costs:	
Product development	$ 500,000
Manufacturing	200,000
Selling	300,000
Total	$1,000,000

Projected break-even: 50,000 units
Decision: Reject
Reason(s): The break-even point is greater than the production capacity as well as the projected sales volume.

In an effort to discover just why the cost figures came out so poorly for a project that both individuals felt strongly would be profitable, the two met with Bob Bronstein, the assistant controller. The following conversation took place:

SHARON: Bob, I would like to know why there is a $3-per-unit scrap cost. Can you explain it?

BOB: Sure. It's based on the scrap cost that we track for existing, similar products.

SHARON: Well, I think you have overlooked the new design features of this new product. Its design virtually eliminates any waste—especially when you consider that the product will be made on a numerically controlled machine.

TERRY: Also, this $2-per-unit charge for repair work should be eliminated. The new design that Sharon is proposing solves the failure problems we have had with related products. It also means that the $100,000 of fixed costs associated with the Repair Centre can be eliminated.

BOB: Sharon, how certain are you that this new design will eliminate some of these quality problems?

SHARON: I'm absolutely positive. The early prototypes did exactly as we expected. The results of those tests are included in the proposal.

BOB: Right. Reducing the variable cost by $5 per unit and the fixed costs by $100,000 produces a break-even point of 36,000 units. These changes alone make the project viable. I'll change the report to reflect a positive recommendation.

The above scenario illustrates the importance of further classifying quality costs by behaviour. Although only unit-based behaviour is assumed, activity-based classification is also possible and could enhance the decision usefulness of quality costs. The scenario also reinforces the importance of identifying and reporting quality costs separately. The new product was designed to reduce its quality costs, and only by knowing the quality costs assigned could Sharon and Terry have discovered the error in the break-even analysis. Finally, notice the effect total quality management has on design decisions. By being aware of the quality costs and their causes, the new product's design was structured to avoid many of the existing quality problems.

Certifying Quality through ISO 9000

Just as a company assesses the quality of its suppliers, that same company may supply other companies that require vendor certification of quality. ISO (pronounced ICE-OH) 9000 is a family of international quality standards developed by the International Organization for Standardization in Geneva, Switzerland, that address quality management. These standards centre on the concept of documentation and control of nonconformance and change. ISO 9000 has been a success in Europe, and U.S. companies doing business in Europe were the first to board the ISO 9000 bandwagon, simply because it was a requirement of doing business there. A program called ISO 9001:2008 has evolved in response to the need for a standardized set of procedures for supplier quality verification.

Companies that attain ISO 9000 certification have been audited by an independent test company, which certifies that the company meets certain quality standards. The standards on which certification is currently based are ISO 9001:2008 standards.

The ISO 9001:2008 standards deal with quality systems and specifically with quality assurance models relating to quality systems that are concerned with such things as design/development, production, installation, final inspection, and testing. Many companies are certified based on 9001:2000 standards, which are essentially the same as those of 2008. The 2008 update is mostly concerned with clarification of the 2000 version of ISO 9001. It is important to understand that these standards do not apply to the production of a particular product or service. Instead, they apply to the way in which a company ensures quality, for example, by testing products, training employees, keeping records, and fixing defects.

Thus, ISO 9001:2008 certification does not certify either the quality of the product itself or the commitment of the company to continuous improvement. As a result, companies that require ISO 9001 certification do not stop auditing their suppliers. Requiring certification is just a first step.

On the plus side, many companies have found that the process of applying for ISO 9001 certification, while lengthy and expensive (it can take many months and cost $1,000,000 or more for larger companies), yields important benefits in terms of self-knowledge and improved financial performance. There are several innovative ways for a company to turn its workforce to ISO and continuous improvement. Posting large placards with simplified instructions and pictures at every workstation ensures that employees know exactly what needs to be done. In addition, replacing paper manuals that are difficult to use with an electronic system easily accessible from each employee's personal computer provides instant guidance and direction.

ISO 9000 is a first step in supplier certification. In 2009, 30,675 ISO 9001 certifications had been awarded in the United States.[8] Many large ISO 9001-certified companies are also urging their suppliers to obtain certificates.

Controlling Quality Costs

OBJECTIVE ➤ 4
Describe and prepare three different types of quality performance reports.

Good quality cost management requires that quality costs be reported and controlled (control having a cost reduction emphasis). Control enables managers to compare actual outcomes with standard outcomes to gauge performance and take any necessary corrective actions. Quality cost performance reports have two essential elements: actual outcomes and standard or expected outcomes. Deviations of actual outcomes from the expected outcomes are used to evaluate managerial performance and provide signals concerning possible problems.

Performance reports are essential to quality improvement programs. A report like the one shown in Cornerstone 16-1 forces managers to identify the various costs that should appear in a performance report, to identify the current quality performance level of the organization, and to begin thinking about the level of quality performance that should be achieved. Identifying the quality standard is a key element in a quality performance report. The standard should emphasize cost reduction opportunities.

Choosing the Quality Standard

The Total Quality Approach The total quality management standard that will be used is referred to as the *robust zero-defects standard*. This standard calls for products and services to be produced and delivered that meet the targeted value. The need for total quality control is inherent in JIT and lean manufacturing approaches. However, JIT or lean manufacturing is not a prerequisite for moving toward total quality control. This approach can stand by itself.

Admittedly, the total quality standard is one that may not be completely attainable; however, evidence exists that it can be closely approximated. Defects are caused either by lack of knowledge or by lack of attention. Lack of knowledge can be corrected by proper training and lack of attention by effective leadership. Note also that total quality control implies the ultimate elimination of failure costs. Those who

[8] See www.anab.org, certification totals, accessed September 24, 2009.

believe that no defects should be permitted will continue to search for new ways to improve quality costs.

Consider the following case. A firm engaged in a significant volume of business through mailings. On average, 15 percent of the mailings were sent to the wrong address. Returned merchandise, late payments, and lost sales all resulted from this error rate. In one case, a tax payment was sent to the wrong address. By the time the payment arrived, it was late, causing a penalty of $300,000. Why not spend the resources (surely less than $300,000) to get the mailing list right and have no errors? Is a mailing list that is 100 percent accurate really impossible to achieve? Why not do it right the first time?

Quantifying the Quality Standard Quality can be measured by its costs; as the costs of quality decrease, higher quality results—at least up to a point. Even if the standard of zero defects is achieved, a company must still have prevention and appraisal costs. A company with a well-run quality management program can get by with quality costs of about 2.5 percent of sales. (If zero defects are achieved, this cost is for prevention and appraisal.) This 2.5 percent standard is accepted by many quality control experts and many firms that are adopting aggressive quality improvement programs.

The 2.5 percent standard is for total costs of quality. Costs of individual quality factors, such as quality training or materials inspection, will be less. Each organization must determine the appropriate standard for each individual factor. Budgets can be used to set spending for each standard so that the total budgeted cost meets the 2.5 percent goal.

Physical Standards For line managers and operating personnel, physical measures of quality—such as number of defects per unit, the percentage of external failures, billing errors, contract errors, and other physical measures—may be more meaningful. For physical measures, the quality standard is zero defects or errors. The objective is to get everyone to do it right the first time.

Use of Interim Standards For most firms, the standard of zero defects is a long-range goal. The ability to achieve this standard is strongly tied to supplier quality. For most companies, materials and services purchased from outside parties make up a significant part of a product's cost. To achieve the desired quality level, a major campaign to involve suppliers in similar quality improvement programs may be needed. Developing the relationships and securing the needed cooperation from suppliers takes time—in fact, it takes years. Similarly, getting people within the company itself to understand the need for quality improvement and to have confidence in the program can take several years.

Because improving quality to the zero-defects level can take years, yearly quality improvement standards should be developed so that managers can use performance reports to assess the progress made on an interim basis. These **interim quality standards** express quality goals for the year. Progress should be reported to managers and employees in order to gain the confidence needed to achieve the ultimate standard of zero defects. Even though reaching the zero-defects level is a long-range project, management should expect significant progress on a yearly basis.

Types of Quality Performance Reports

Quality performance reports measure the progress realized by an organization's quality improvement program. Three types of progress can be measured and reported:

1. Progress with respect to a current-period standard or goal (an interim standard report)
2. The progress trend since the inception of the quality improvement program (a multiple-period trend report)
3. Progress with respect to the long-range standard or goal (a long-range report)

Interim Standard Report The organization must establish an interim quality standard each year and make plans to achieve this targeted level. Since quality costs are a measure of quality, the targeted level can be expressed in dollars budgeted for each category of quality costs and for each cost item within the category. Often, the interim quality standard is simply the quality costs incurred in the previous year, adjusted for management's desired reduction. At the end of the period, the **interim quality performance report** compares the actual quality costs for the period with the budgeted costs. This report measures the progress achieved within the period relative to the planned level of progress for that period. Cornerstone 16-2 illustrates such a report.

Multiple-Period Trend Report The interim quality report provides management with information concerning the within-period progress measured relative to specific goals. Also useful is a picture of how the quality improvement program has been doing since its inception. Is the multiple-period trend—the overall change in quality costs—moving in the right direction? Are significant quality gains being made each period? Answers to these questions can be given by providing a chart or graph that tracks the change in quality from the beginning of the program to the present. Such a graph is called a **multiple-period quality trend report**. By plotting quality costs as a percentage of sales against time, the overall trend in the quality program can be assessed. The first year plotted is the year prior to the implementation of the quality improvement program. Cornerstone 16-3 provides a detailed example of multiple-period trend reporting.

Long-Range Report At the end of each period, a report that compares the period's actual quality costs with the costs that the firm eventually hopes to achieve should be prepared. This report forces management to keep the ultimate quality goal in mind, reveals the room left for improvement, and facilitates planning for the coming period. Under a zero-defects philosophy, the costs of failure should be virtually nonexistent. (They are non-value-added costs.) Reducing the costs of failure increases a firm's competitive ability. It may also result in lowering external failure rates.

Remember that achieving higher quality will not totally eliminate prevention and appraisal costs. (In fact, increased emphasis on zero defects may actually increase the cost of prevention, depending on the type and level of prevention activities initially present.) Generally, we would expect appraisal costs to decrease significantly. Product acceptance, for example, may be phased out entirely as product quality increases; however, increased emphasis on process acceptance is likely. The firm must have assurance that the process is operating in a zero-defects mode. A **long-range quality performance report** compares the current actual costs with the costs that would be allowed if the zero-defects standard were being met (assuming a sales level equal to that of the current period). The target costs are, if chosen properly, value-added costs. The variances are non-value-added costs. Thus, the long-range performance report is simply a variation of the value- and non-value-added cost report. Cornerstone 16-4 illustrates this long-range report.

Incentives for Quality Improvement Most organizations provide both monetary and nonmonetary recognition for significant contributions to quality improvement. Of the two types of incentives, many quality experts believe that the nonmonetary are more useful.

Nonmonetary Incentives As with budgets, participation helps employees internalize quality improvement goals as their own. One approach used by many companies in their efforts to involve employees is the use of error cause identification forms. **Error cause identification** is a program in which employees describe problems that interfere with their ability to do the job right the first time. The error-cause-removal approach is one of the 14 steps in Philip Crosby's quality improvement program.[9]

[9] Philip Crosby, *Quality Is Free* (New York: New American Library, 1980).

CORNERSTONE 16-2

The HOW and WHY of Preparing Interim Quality Performance Reports

Information:

The actual quality costs of AMD Inc. for years ended June 30, 2012 and 2013, are provided:

	2012	2013
Prevention costs:		
Quality training	$ 64,000	$ 80,000
Reliability engineering	128,000	160,000
Appraisal costs:		
Materials inspection	66,400	84,000
Process acceptance	76,000	96,000
Internal failure costs:		
Scrap	55,000	50,000
Rework	120,625	100,000
External failure costs:		
Customer complaints	81,250	65,000
Warranty	184,375	165,000

At the end of 2012, management decided to increase its investment in control costs by 25 percent for each category's items with the expectation that failure costs would decrease by 20 percent for each item of the failure categories. Sales were $8,000,000 for both 2012 and 2013.

Why:

The quality standard expressed in dollars for a given year represents the budgeted costs for that year. Budgeted costs are a reduction in the prior year's quality costs resulting from planned quality improvements. An interim quality performance report compares actual quality costs with budgeted quality costs.

Required:

1. Calculate the budgeted costs for 2013, and prepare an interim quality performance report.
2. Comment on the significance of the report. How much progress has AMD made?
3. ***What if*** sales were $8,000,000 for 2012 and $10,000,000 for 2013? What adjustment to budgeted scrap costs would be made? Budgeted quality training? Assuming the actual costs for 2013 do not change, what does this adjustment say about AMD's performance?

Solution:

1.

AMD Inc.
Interim Standard Performance Report: Quality Costs
For the Year Ended June 30, 2013

	Actual Costs	Budgeted Costs	Variance
Prevention costs:			
Quality training	$ 80,000	$ 80,000[a]	$ 0
Reliability engineering	160,000	160,000[a]	0
Total prevention costs	$240,000	$240,000	$ 0

CORNERSTONE 16-2 *(continued)*

	Actual Costs	Budgeted Costs	Variance
Appraisal costs:			
Materials inspection	$ 84,000	$ 83,000[a]	$ 1,000 U
Process acceptance	96,000	95,000[a]	1,000 U
Total appraisal costs	180,000	178,000	2,000 U
Internal failure costs:			
Scrap	50,000	44,000[b]	6,000 U
Rework	100,000	96,500[b]	3,500 U
Total internal failure costs	150,000	140,500	9,500 U
External failure costs:			
Customer complaints	65,000	65,000[b]	0
Warranty	165,000	147,500[b]	17,500 U
Total external failure costs	230,000	212,500	17,500 U
Total quality costs	$800,000	$771,000	$29,000 U
Percentage of sales	10.0%	9.64%	0.36% U

[a] 2012 actual control cost × 1.25 (e.g., quality training = $64,000 × 1.25 = $80,000)
[b] 2012 actual failure cost × 0.80 (e.g., scrap = $55,000 × 0.80 = $44,000)

2. AMD has come very close to meeting the planned outcomes (only 0.36 percent short overall). Thus, management's belief that investing an additional 25 percent in control costs would produce a 20 percent reduction in failure costs seems to be validated.
3. Scrap would be expected to vary with sales. Thus, a 20 percent increase in sales would cause a 20 percent increase in budgeted scrap costs: $44,000 × 1.20 = $52,800. This would create a favourable scrap variance of $2,800 ($50,000 − $52,800). All variable costs would have increased budgets, and the budgeted variance would be more favourable than initially calculated. Quality training is likely a discretionary fixed cost and so its budget would not be affected by changes in sales revenue.

To ensure the success of the program, each employee submitting an entry should receive a note of appreciation from management. Additional recognition should be given to those who submit particularly beneficial information.

Other nonfinancial awards can also be given to recognize employees for their efforts. One restaurant, for example, gives monthly awards to food servers who have made no errors when punching diners' orders into the kitchen printout computer. Servers who make the most errors see their names posted on an error list (no punishment, just names). The error rate has plummeted, saving the restaurant thousands of dollars a month in wasted food.[10] The important thing is not the award itself but public recognition that leads to improved performance. By publicly recognizing significant quality contributions, management underscores its commitment to quality improvement. Also, the individuals and groups so recognized feel the benefits of that recognition, which include pride, job satisfaction, and a further commitment to quality.

Monetary Incentives **Gainsharing** provides cash incentives for a company's entire workforce that are keyed to quality or productivity gains. For example, suppose a

[10] Leonard L. Berry and A. Parasuramna, *Marketing Services: Competing Through Quality* (New York: The Free Press, Macmillan, 1991).

CORNERSTONE 16-3

The HOW and WHY of Multiple-Period Quality Trend Reporting

Information:

Assume that AMD Inc. has experienced the following:

	Quality Costs	Actual Sales	Costs as a Percentage of Sales
2009	$1,000,000	$5,000,000	20.0%
2010	990,000	5,500,000	18.0
2011	900,000	6,000,000	15.0
2012	868,000	6,200,000	14.0
2013	800,000	8,000,000	10.0

By cost category as a percentage of sales for the same period of time:

	Prevention	Appraisal	Internal Failure	External Failure
2009	2.0%	2.0%	6.0%	10.0%
2010	3.0	2.4	4.0	8.6
2011	3.0	3.0	3.0	6.0
2012	4.0	3.0	2.5	4.5
2013	4.1	2.4	2.0	1.5

Why:

Trend in quality costs as a percentage of sales reveals the effects of quality improvement initiatives over time. Expressing these trends by quality cost category provides insight concerning the effect of quality improvement initiatives on the relative distribution of quality costs.

Required:

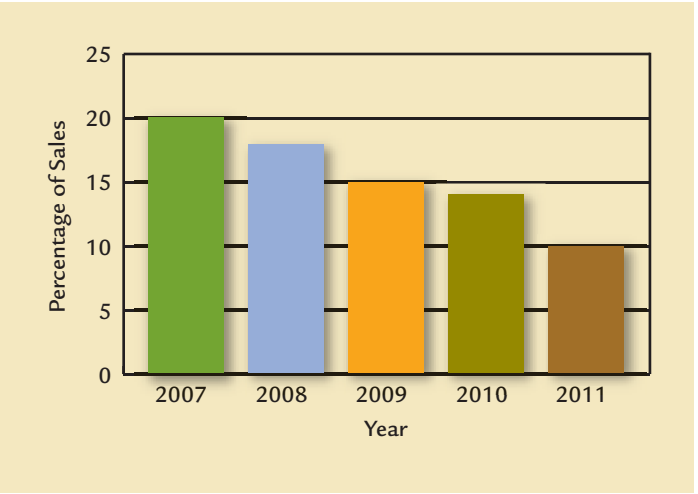
1. Prepare a bar graph that reveals the trend in quality cost as a percentage of sales (time on the horizontal axis and percentages on the vertical). Comment on the message of the graph.
2. Prepare a bar graph for each cost category as a percentage of sales. What does this graph tell you?
3. ***What if*** management would like to have the trend in *relative* distribution of quality costs? Express this as a bar graph and comment on its significance.

Solution:

1. See Exhibit 16-5. It is clear that there has been a steady downward trend in quality costs as a percentage of sales (dropping from 20 percent to 10 percent). The graph also reveals that there is still ample room for improvement.
2. See Exhibit 16-6. From Exhibit 16-6, we can see that AMD has had dramatic success in reducing internal and external failure costs. More money is being spent on prevention (the percentage has doubled). Also, appraisal costs have increased and then decreased, suggesting that AMD is becoming more confident in its prevention initiatives.
3. See Exhibit 16-7 (p. 802). This graph reveals that failure costs have gone from 80 percent of the total quality costs (16%/20%) to 35 percent (3.5%/10%), whereas control costs have gone from 20 percent to 65 percent. It appears that increasing prevention costs (value-added) has caused the failure costs (non-value-added) to decrease.

Exhibit 16-5

Multiple-Period Trend Graph: Total Quality Costs



company has a target of reducing the number of defective units by 10 percent during the next quarter for a particular plant. If the goal is achieved, the company estimates that $1,000,000 will be saved (through avoiding such things as rework and warranty repairs). Gainsharing provides an incentive by offering a bonus to the employees equal to a percentage (say 20 percent) of the cost savings.

Defining, Measuring, and Controlling Environmental Costs

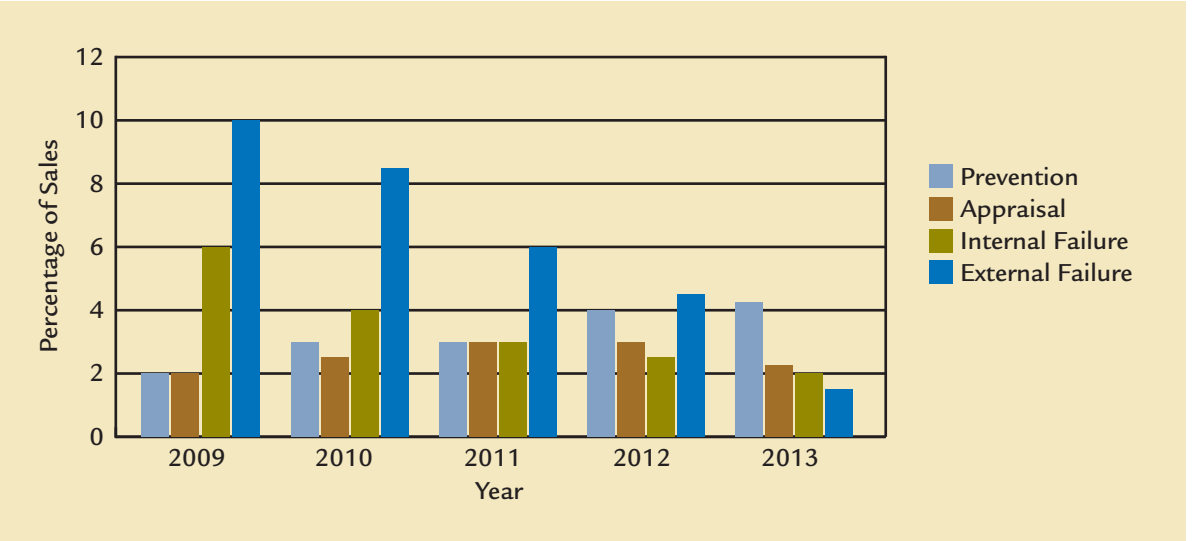
OBJECTIVE 5

Discuss how environmental costs can be measured, reported, and reduced.

Historically, firms have often released contaminants into the atmosphere and water without bearing the full cost of such activities. Many people believe that polluters should bear the full cost of any environmental damage caused by production of goods and services (the polluter pays principle). By bearing the full cost (it is argued), firms may then seek more *ecoefficient* production methods. Interestingly, some initial experiences suggest that it may be possible to improve environmental quality without

Exhibit 16-6

Multiple-Period Trend Graph: Individual Quality Cost Categories



CORNERSTONE 16-4

The HOW and WHY of Long-Range Quality Performance Reporting

Information:

The actual quality costs for the year ended June 30, 2013, for AMD Inc. are given below:

Prevention costs:	
Quality training	$ 80,000
Reliability engineering	160,000
Total prevention costs	240,000
Appraisal costs:	
Materials inspection	84,000
Process acceptance	96,000
Total appraisal costs	180,000
Internal failure costs:	
Scrap	50,000
Rework	100,000
Total internal failure costs	150,000
External failure costs:	
Customer complaints	65,000
Warranty	165,000
Total external failure costs	230,000
Total quality costs	$800,000

At the zero-defect state, AMD expects to spend $50,000 on quality training, $100,000 on reliability engineering, and $25,000 on process acceptance. Assume sales of $8,000,000.

Why:

The long-range performance report compares the current actual costs with the costs that would be present if no poor quality existed. It is, in effect, a listing of the non-value-added costs and reflects the potential for further savings by improving quality.

Required:

1. Prepare a long-range performance report for 2013. What does this report tell the management of AMD?
2. Explain why quality costs still are present for the zero-defect state.
3. ***What if*** AMD achieves the zero-defect state reflected in the report? What are some of the implications of this achievement?

Solution:

1.

AMD Inc.
Long-Range Performance Report
For the Year Ended June 30, 2013

	Actual Costs	Target Costs	Variance
Prevention costs:			
Quality training	$ 80,000	$ 50,000	$ 30,000 U
Reliability engineering	160,000	100,000	60,000 U
Total prevention costs	$240,000	$150,000	$ 90,000 U

CORNERSTONE 16-4 *(continued)*

	Actual Costs	Target Costs	Variance
Appraisal costs:			
Materials inspection	$ 84,000	$ 0	$ 84,000 U
Process acceptance	96,000	25,000	71,000 U
Total appraisal costs	180,000	25,000	155,000 U
Internal failure costs:			
Scrap	50,000	0	50,000 U
Rework	100,000	0	100,000 U
Total internal failure costs	150,000	0	150,000 U
External failure costs:			
Customer complaints	65,000	0	65,000 U
Warranty	165,000	0	165,000 U
Total external failure costs	230,000	0	230,000 U
Total quality costs	$800,000	$175,000	$625,000 U
Percentage of sales	10.0%	2.2%	7.81% U

AMD is spending too much money on failure activities. More effort at improving quality is still needed.

2. Prevention costs are value-added costs and would be necessary to maintain the quality gains. The presence of appraisal costs may not be necessary in a strictly theoretical sense (if there are no defective units, then there is no need to engage in detection activities).
3. By spending less money on defects, AMD can use the savings to expand and to employ additional people to support this expansion. Improved quality may naturally cause expansion by enhancing its competitive position. Thus, although improved quality may mean fewer jobs in some areas (such as inspection and warranty service), it also means that additional jobs will be created through expanded business activity.

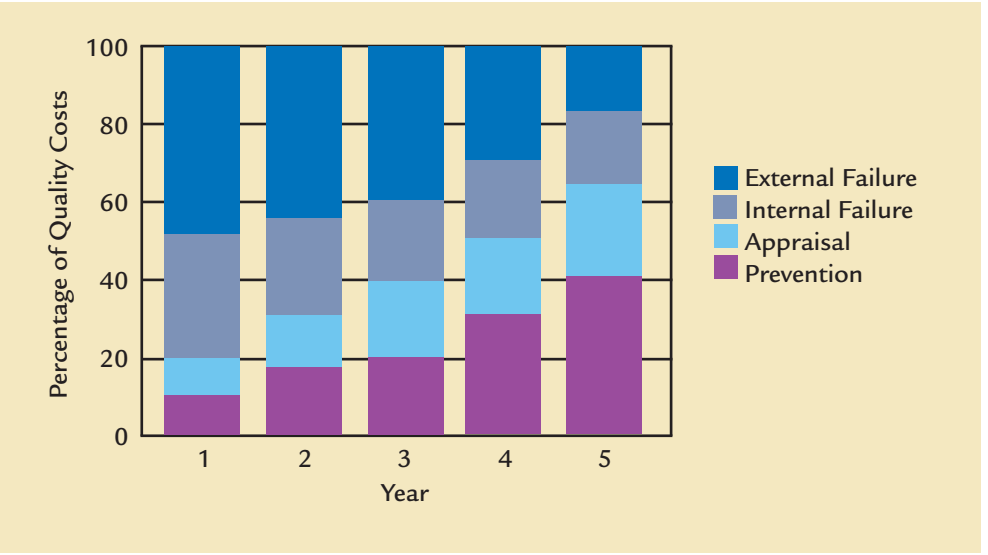
reducing useful goods and services while simultaneously increasing profits. If true, then a more proactive approach is both needed and appropriate. Moreover, proactive environmental decisions require information about environmental costs and benefits—information that has not existed as a separate and well-defined category. According to a concept known as *ecoefficiency*, meeting sound business objectives and resolving environmental concerns are not mutually exclusive.

The Ecoefficiency Paradigm

Ecoefficiency is defined as the ability to produce competitively priced goods and services that satisfy customer needs while *simultaneously* reducing negative environmental impacts, resource consumption, and costs. Ecoefficiency means producing more goods and services using less materials, energy, water, and land, while, at the same time, minimizing air emissions, water discharges, waste disposal, and the dispersion of toxic substances. However, perhaps the most important claim of the ecoefficiency paradigm is that preventing pollution and avoiding waste is economically beneficial—that it is possible to do more with less. Moreover, it is complementary to and supportive of *sustainable development*. **Sustainable development** is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Although absolute sustainability may not be attainable, progress toward its achievement certainly seems to have some merit.

Exhibit 16-7

Multiple-Period Trend Graph: Relative Quality Costs



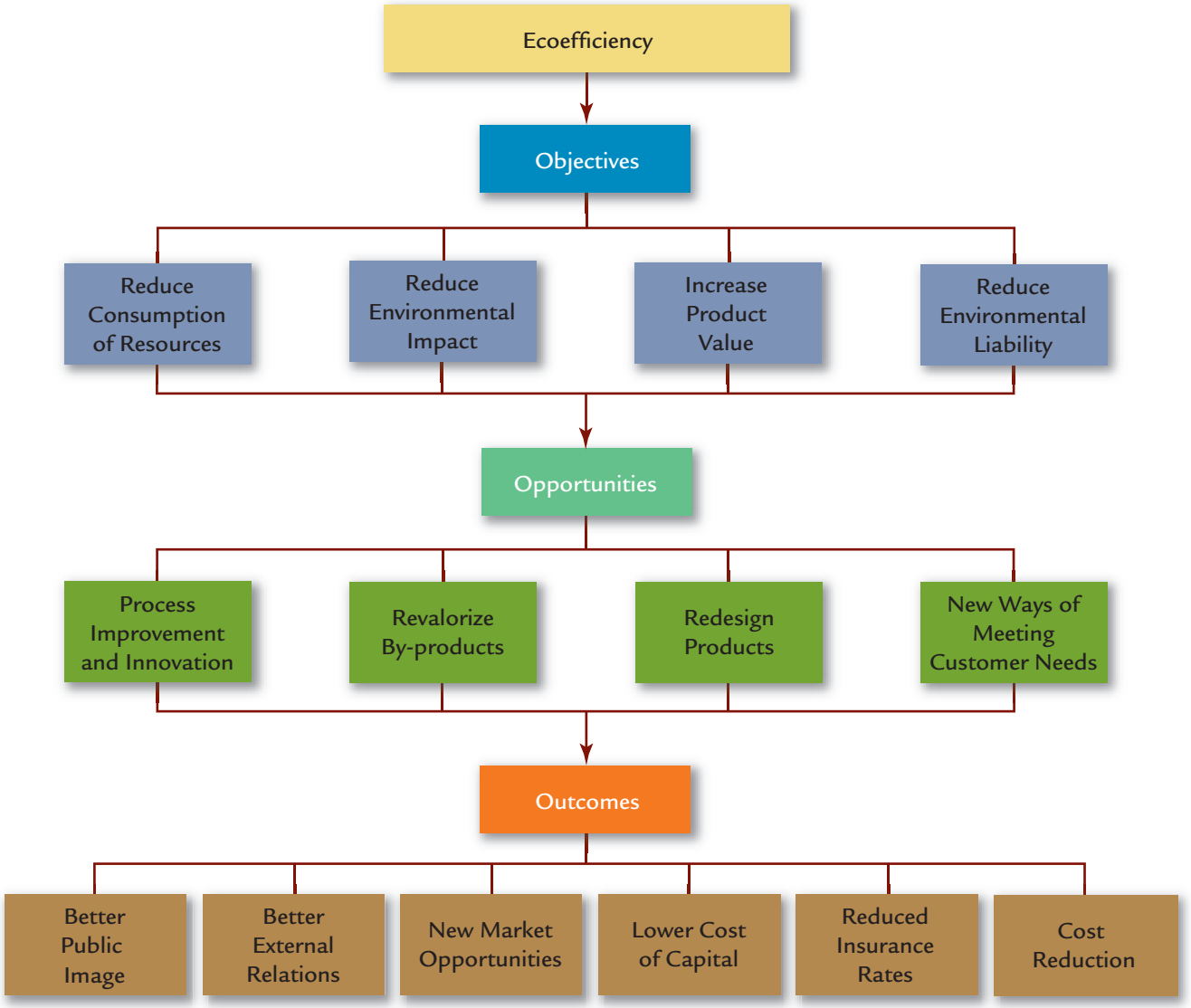
Ecoefficiency implies a positive relationship between environmental and economic performance. Exhibit 16-8 illustrates the objectives, opportunities, and outcomes that define the relationships envisioned by ecoefficiency.[11] Four broad objectives are revealed: (1) reduce the consumption of resources, (2) reduce the environmental impact, (3) increase product value, and (4) reduce environmental liability. Reducing the consumption of resources entails such things as reducing the use of energy, materials, water, and land. It also includes increasing product durability and enhancing product recyclability. Reducing environmental impact is primarily concerned with minimizing releases of pollutants into the environment and encouraging the sustainable use of renewable resources. Increasing product value means that products are produced that provide the functionality that customers need but with fewer materials and less resources. It also means that products are produced without degrading the environment, and their use and disposal are environmentally friendly. Reducing environmental liability requires that a company identify and efficiently manage the risks and opportunities relating to the environment. Achievement of the objectives requires a firm to seek opportunities to improve ecoefficiency, which brings us to the second level of Exhibit 16-8.

Process improvement and innovation are familiar methods for increasing efficiency. In this case, however, the objective is to increase ecoefficiency, which means that process changes must focus simultaneously on reducing costs and improving environmental performance. Process improvement is most useful for improving relative environmental performance, but process re-engineering is probably more suitable for major advances in ecoefficiency. Revalorizing by-products describes the search for ways to convert waste materials into useful products or useful inputs for other companies' products. For example, the sludge from wastewater treatment facilities can be converted into commercial compost. Product redesign is another key method for improving ecoefficiency. Products can be redesigned so that they use fewer materials, a smaller variety of materials, and less toxic materials and are easier to take apart for recycling while simultaneously providing a high degree of functionality for users. Finally, ecoefficiency can be improved by finding different and better ways of satisfying customer needs. This may entail redefining markets and reshaping supply and demand. For example, providing a service instead of selling a product has the potential of creating higher resource efficiency and less pollution. Car sharing is an example of this last approach.

[11] The objectives and opportunities are those identified by the World Business Council for Sustainable Development (WBCSD). See WBCSD, "Eco-efficiency: Creating More Value with Less Impact," (October 1, 2000), http://www.wbcsd.org/web/publications/eco_efficiency_creating_more_value.pdf.

Exhibit 16-8

Ecoefficiency Relationships



Zipcar is a membership-based auto-sharing company that provides car reservations to its members. Its cars are billable by the hour or the day. The company parks cars at convenient locations around major centres. Members can reserve Zipcars online or by phone 24/7. They have automated access to Zipcars using an access card, which unlocks the door. The customer then finds the car keys inside. Membership is about $65 per year. Rates vary by city, day of the week, and vehicle make and model. Gas, parking, insurance, and maintenance are included in the price. Zipcar was founded in 2000 in Cambridge, Massachusetts, and today operates in major U.S. cities, in Toronto and Vancouver, and in the U.K. It has some 700,000 members.[12]

The third and final level of Exhibit 16-8 illustrates the payoffs of ecoefficiency. Pursuing the opportunities just discussed can produce a number of beneficial outcomes. Reduced environmental impacts can create social benefits like a better public image and better relations in the community and with regulators. This, in turn,

[12] Ibid.

improves the company's image and enhances its ability to sell products and services. Efforts to improve ecoefficiency also may increase revenues by creating new markets (e.g., creating outputs that were formerly classified as useless residues). Ecoefficient firms tend to reduce their environmental risks and, consequently, capture external benefits such as a lower cost of capital and lower insurance rates. Finally, cost reductions follow improvements in environmental performance.

The cost reduction outcome is particularly important. Environmental costs can be a significant percentage of total operating costs; many of these costs can be reduced or eliminated through effective management. For example, knowledge of environmental costs and their causes may lead to redesign of a process that, as a consequence, reduces the materials used and the pollutants emitted to the environment (an interaction between the innovation and cost reduction incentives). Thus, current and future environmental costs are reduced, and the firm becomes more competitive. To provide this financial information, it is necessary to define, measure, classify, and assign environmental costs to processes, products, and other cost objects of interest.

Environmental Costs Defined

Before environmental cost information can be provided to management, environmental costs must be defined. Various possibilities exist; however, an appealing approach is to adopt a definition consistent with a total environmental quality model. In the total environmental quality model, the ideal state is that of zero damage to the environment (analogous to the zero-defects state of total quality management). *Damage* is defined as either direct degradation of the environment such as the emission of solid, liquid, or gaseous residues into the environment (e.g., water contamination and air pollution) or indirect degradation such as *unnecessary* usage of materials and energy. Accordingly, environmental costs can be referred to as *environmental quality costs*. In a similar sense to quality costs, **environmental costs** are costs that are incurred because poor environmental quality exists or *may* exist. Thus, environmental costs are associated with the creation, detection, remediation, and prevention of environmental degradation. With this definition, environmental costs can be classified into four categories:

1. **Environmental prevention costs** are the costs of activities carried out to prevent the production of contaminants and/or waste that could cause damage to the environment.
2. **Environmental detection costs**are the costs of activities executed to determine if products, processes, and other activities within the firm are in compliance with appropriate environmental standards. The environmental standards and procedures that a firm seeks to follow are defined in three ways: (1) regulatory laws of governments, (2) voluntary standards (ISO 14000) developed by the International Standards Organization, and (3) environmental policies developed by management.
3. **Environmental internal failure costs** are costs of activities performed because contaminants and waste have been produced but not discharged into the environment. Thus, internal failure costs are incurred to eliminate and manage contaminants or waste once produced. Internal failure activities have one of two goals: (1) to ensure that the contaminants and waste produced are not released to the environment or (2) to reduce the level of contaminants released to an amount that complies with environmental standards.
4. **Environmental external failure costs** are the costs of activities performed *after* discharging contaminants and waste into the environment. **Realized external failure costs** are those incurred and paid for by the firm. **Unrealized external failure (societal) costs** are caused by the firm but are incurred and paid for by parties outside the firm. Societal costs can be further classified as (1) those resulting from environmental degradation and (2) those associated with an adverse impact on the property or welfare of individuals. In either case, the costs are borne by others and not by the firm even though the firm causes them.

Exhibit 16-9

Classification of Environmental Costs by Activity Type

Prevention Activities	Internal Failure Activities
Evaluating and selecting suppliers	Operating pollution control equipment
Evaluating and selecting pollution control equipment	Treating and disposing of toxic waste
Designing processes	Maintaining pollution equipment
Designing products	Licensing facilities for producing contaminants
Carrying out environmental studies	Recycling scrap
Auditing environmental risks	
Developing environmental management systems	
Recycling products	
Obtaining ISO 14001 certification	
Detection Activities	**External Failure Activities**
Auditing environmental activities	Cleaning up a polluted lake
Inspecting products and processes	Cleaning up oil spills
Developing environmental performance measures	Cleaning up contaminated soil
Testing for contamination	Settling personal injury claims (environmentally related)
Verifying supplier environmental performance	Restoring land to natural state
Measuring contamination levels	Losing sales due to poor environmental reputation
	Using materials and energy inefficiently
	Receiving medical care due to polluted air (S)
	Losing employment because of contamination (S)
	Losing a lake for recreational use (S)
	Damaging ecosystems from solid waste disposal (S)

Note: "S" = societal costs.

Exhibit 16-9 summarizes the four environmental cost categories and lists specific activities for each category. Within the external failure cost category, societal costs are labelled with an "S." The costs for which the firm is financially responsible are called **private costs**. All costs without the S label are private costs. Of the four categories of environmental activities, the external failure cost category is the one that causes the most economic hardship for an organization.

Environmental Cost Report

Environmental cost reporting is essential if an organization is serious about improving its environmental performance and controlling environmental costs. Reporting environmental costs by category reveals two important outcomes: (1) the impact of environmental costs on firm profitability and (2) the relative amounts expended in each category. Cornerstone 16-5 provides an example of a simple environmental cost report.

Environmental Cost Reduction

Investing more in prevention and detection activities can bring about a significant reduction in environmental failure costs. Environmental costs appear to behave in much the same way as quality costs. The lowest environmental costs are attainable at the *zero-damage point* much like the zero-defects point of the total quality cost model. Thus, an ecoefficient solution would focus on prevention with the usual justification that *prevention is cheaper than the cure*. Analogous to the total quality management model, zero damage is the lowest cost point for environmental costs.

CORNERSTONE 16-5

The HOW and WHY of an Environmental Cost Report

Information:

Operating costs for Verde Corporation as of December 31, 2013, are $30,000,000. Environmental costs are as follows:

Maintaining pollution equipment	$ 400,000
Developing measures	240,000
Operating pollution equipment	1,200,000
Designing products	600,000
Training employees	240,000
Restoring land	2,100,000
Inspecting processes	720,000
Cleaning up lake	3,300,000

Required:

1. Prepare an environmental cost report, classifying costs by quality category and expressing each as a percentage of total operating costs. What is the message of this report?
2. Prepare a pie chart that shows the relative distribution of environmental costs by category. What does this report tell you?
3. ***What if*** Verde deliberately did not include the cost of polluting a lake in the report? Offer possible reasons for this decision.

Solution:

1.

Verde Corporation
Environmental Cost Report
For the Year Ended December 31, 2013

	Environmental Costs		Percentage of Operating Costs[a]
Prevention costs:			
Training employees	$ 240,000		
Designing products	600,000	$ 840,000	2.80%
Detection costs:			
Inspecting processes	720,000		
Developing measures	240,000	960,000	3.20
Internal failure costs:			
Operating pollution equipment	1,200,000		
Maintaining pollution equipment	400,000	1,600,000	5.33
External failure costs:			
Cleaning up lake	3,300,000		
Restoring land	2,100,000	5,400,000	18.00
Total quality costs		$8,800,000	29.33%[b]

[a] Actual opening costs of $30,000,000.
[b] $8,800,000/$30,000,000 = 29.33%

Environmental costs are 29.33 percent of total operating costs, seemingly a significant amount. Reducing environmental costs by improving environmental performance can significantly increase a firm's profitability.

2. See Exhibit 16-10. Of the total environmental costs, only 21 percent are from the prevention and detection categories, and 79 percent of the environmental costs are failure costs. Thus, increasing prevention activities should drive down the costs of failure activities in a way that is cost beneficial.
3. The most likely reason is that the cost is a social cost and not paid for by the company and thus not of direct interest to Verde. In fact, such formal recognition may create a potential liability for the company (Could this be an ethical issue?).

CORNERSTONE 16-5 *(continued)*

An Environmental Financial Report

Ecoefficiency suggests a possible modification to environmental cost reporting. Specifically, in addition to reporting environmental costs, why not report *environmental benefits*? In a given period, there are three types of benefits:

1. Additional revenues
2. Current savings
3. Cost avoidance (ongoing savings)

Additional revenues are revenues that flow into the organization due to environmental actions such as recycling paper, finding new applications for nonhazardous waste (e.g., using wood scraps to make wood chess pieces and boards), and increased sales due to an enhanced environmental image. Current savings refer to reductions in environmental costs achieved in the current year. Cost avoidance refers to ongoing savings of costs that had been paid in prior years. By comparing benefits produced with environmental costs incurred in a given period, a type of environmental financial statement is produced. Managers can use this statement to assess progress (benefits produced) and potential for progress (environmental costs). The environmental financial statement could also form part of an environmental progress report that is provided to shareholders on an annual basis. Exhibit 16-11 provides an example of an

Exhibit 16-10

Relative Distribution: Environmental Costs

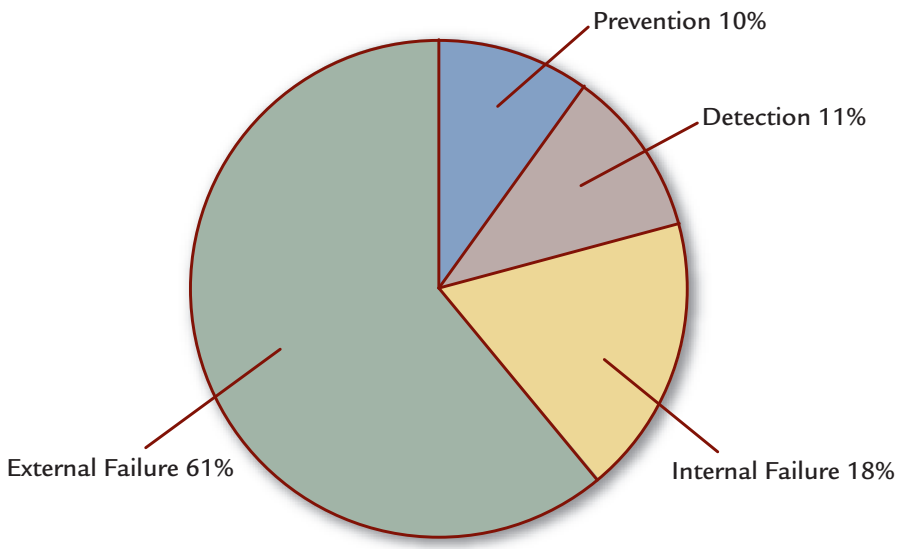


Exhibit 16-11

Environmental Financial Statement

Verde Corporation
Environmental Financial Statement
For the Year Ended December 31, 2013

Environmental benefits:	
Income sources:	
Recycling income	$ 600,000
Revenues from waste-derived products	150,000
Ongoing savings:	
Cost reductions, contaminants	900,000
Cost reductions, hazardous waste disposal	1,200,000
Current savings:	
Energy conservation cost savings	300,000
Packaging cost reductions	450,000
Total environmental benefits	$3,600,000
Environmental costs:	
Prevention costs:	
Designing processes for the environment	$ 640,000
Supplier evaluation and selection	200,000
Detection costs:	
Testing for contamination	560,000
Measuring contamination levels	400,000
Internal failure costs:	
Waste treatment, transport, and disposal	1,500,000
Operating pollution control equipment	300,000
External failure costs:	
Inefficient materials usage	1,400,000
Cleaning up soil	4,000,000
Total environmental costs	$9,000,000

environmental financial statement. The benefits reported reveal good progress, but the costs are still two and one-half times the benefits, indicating that more improvements are clearly needed.

Assigning Environmental Costs to Products and Processes

OBJECTIVE 6
Show how environmental costs can be assigned to products and processes.

Both products and processes are sources of environmental costs. Processes that *produce* products can create solid, liquid, and gaseous residues that are subsequently introduced into the environment. These residues have the potential of degrading the environment. Residues, then, are the causes of both internal and external environmental failure costs (e.g., investing in equipment to prevent the introduction of the residues into the environment and cleaning up residues after they are allowed into the environment). Production processes are not the only source of environmental costs. Packaging is also a source.

Products themselves can be the source of environmental costs. After selling a product, its use and disposal by the customer can produce environmental degradation. These are examples of *environmental post-purchase costs.* Most of the time, environmental post-purchase costs are borne by society and not by the company and, thus, are societal costs. On occasion, however, environmental post-purchase costs are converted into realized external costs.

The environmental costs of processes that produce, market, and deliver products and the environmental post-purchase costs caused by the use and disposal of the

products are examples of *environmental product costs.* **Full environmental costing** is the assignment of all environmental costs, both private and societal, to products. **Full private costing** is the assignment of only private costs to individual products. Private costing, then, would assign the environmental costs to products caused by the internal processes of the organization. Private costing is probably a good starting point for many firms. Private costs can be assigned using data created *inside* the firm. Full costs require gathering of data that are produced outside the firm by third parties.

Assigning environmental costs to products can produce valuable managerial information. For example, it may reveal that a particular product is responsible for much more toxic waste than other products. This information may lead to an alternative design for the product or its associated processes that is more efficient and environmentally friendly. It could also reveal that with the environmental costs correctly assigned, the product is not profitable. This could mean something as simple as dropping the product to achieve significant improvement in environmental performance and economic efficiency. Many opportunities for improvement may exist, but knowledge of the environmental product costs is the key. Moreover, environmental costs must be assigned accurately.

Activity-Based Environmental Cost Assignments

The environmental costs of processes that produce, market, and deliver products and the environmental post-purchase costs caused by the use and disposal of the products are examples of *environmental product costs.*

Activity-based costing facilitates environmental costing. Tracing the environmental costs to the products responsible for those costs is a fundamental requirement of a sound environmental accounting system. Each environmental activity is assigned costs, activity rates are computed, and the rates are then used to assign environmental costs to products based on usage of the activity. Cornerstone 16-6 shows how to assign environmental costs to two different types of industrial cleaners.

The HOW and WHY of Activity-Based Environmental Cost Assignments

CORNERSTONE 16-6

Information:

Pelideaen Company reported the following:

1. Environmental activity costs

Activity	Costs
Design processes (to reduce pollution)	$ 45,000
Inspect processes (for pollution problems)	80,000
Maintain environmental equipment	125,000
Toxic waste disposal	200,000

2. Driver data

	Cleanser A	Cleanser B
Design hours	2,000	1,000
Inspection hours	1,750	2,250
Maintenance hours	200	4,800
Kilograms of waste	1,000	19,000

CORNERSTONE 16-6 *(continued)*

3. Other production data

	Cleanser A	Cleanser B
Nonenvironmental production costs	$920,000	$1,630,000
Units produced	100,000	100,000

Why:

Activity-based assignments of environmental costs can provide managers the ability to assess the relative environmental impact of various products. Knowing this allows them to devise ways to improve the environmental impact of their products.

Required:

1. Calculate the activity rates that will be used to assign environmental costs to products.
2. Determine the unit environmental and unit costs of each product using ABC.
3. ***What if*** the design costs increased to $80,000 and the cost of toxic waste decreased to $100,000? Assume that Product B uses 2,000 out of 4,000 design hours. Also assume that toxic waste is cut in half and that Cleanser B uses 9,000 of 10,000 kilograms of toxic waste. What is the new environmental cost for Cleanser B?

Solution:

1. Rates:

   Design process: $45,000/3,000 = $15 per design hour
   Inspection: $80,000/4,000 = $20 per inspection hour
   Maintaining equipment: $125,000/5,000 = $25 per maintenance hour
   Waste disposal: $200,000/20,000 = $10 per kilogram

2. Product costs:

Activities	Cleanser A	Cleanser B
Design processes ($15 × 2,000; $15 × 1,000)	$ 30,000	$ 15,000
Inspect processes ($20 × 1,750; $20 × 2,250)	35,000	45,000
Maintain equipment ($25 × 200; $25 × 4,800)	5,000	120,000
Toxic waste disposal ($10 × 1,000; $10 × 19,000)	10,000	190,000
Total environmental cost	80,000	370,000
Other manufacturing costs (nonenvironmental)	920,000	1,630,000
Total cost (environmental + other)	$1,000,000	$2,000,000
Unit environmental cost*	$0.80	$3.70
Unit cost (environmental + other)*	$10.00	$20.00

*Cost divided by 100,000 units.

3. Using the associated activity rates of $20 per design hour ($80,000/4,000) and $10 per kilogram of waste ($100,000/10,000), the design cost assigned to B increases by $25,000 ($15,000 to $40,000), and the toxic waste cost assigned to B decreases by $100,000 ($190,000 to $90,000). The net decrease is $75,000 ($100,000 – $25,000), and the total environmental cost for B decreases to $295,000 ($370,000 – $75,000); thus, the unit environmental cost for Cleanser B is now $2.95 ($295,000/100,000).

The cost assignments shown in Cornerstone 16-6 allow managers to see the relative environmental economic impact of the two products, and to the extent that environmental costs reflect environmental damage, the unit environmental cost can also act as an index or measure of product cleanliness. The "dirtier" products can then be the focus of efforts to improve environmental performance and economic efficiency. Cornerstone 16-6 reveals, for example, that Cleanser B has more environmental problems than Cleanser A. Cleanser B's environmental costs total $370,000 ($3.70 × 100,000) and are 18.5 percent of the total manufacturing costs. Furthermore, its environmental failure costs (maintenance plus toxic waste) are $310,000, representing 83.8 percent of the total environmental costs. Cleanser A portrays a much better picture. Its environmental costs total $80,000, which is 8.0 percent of the total manufacturing costs, and the failure costs are 18.75 percent of the total environmental costs. It is evident that Cleanser B offers the most environmental and economic potential for improvement.

Summary of Learning Objectives

1. Define quality, describe the four types of quality costs, and discuss the approaches used for quality cost measurement.

- Quality costs are those costs that are incurred because products may fail or actually fail to meet design specifications.
- Prevention costs are those costs incurred to prevent poor quality.
- Appraisal costs are incurred to detect poor quality.
- Internal failure costs are incurred because products fail to conform to specifications and are discovered before an external sale takes place.
- External failure costs are incurred because products fail to conform to expectations after being sold.

2. Prepare a quality cost report, and explain its use.

- A quality cost report is prepared by listing costs for each item within each of the four major quality cost categories.
- Knowing the magnitude of quality costs allows managers to assess their financial impact.
- Knowing the distribution of quality costs by category allows managers to assess the relative importance of each category.

3. Explain why quality cost information is needed and how it is used.

- Quality cost information is needed to help managers control quality performance and to serve as input for decision making.
- Quality cost information also is used to evaluate the overall performance of quality improvement programs.
- Quality cost information is fundamental in a company's pursuit of continual improvement.

4. Describe and prepare three different types of quality performance reports.

- The interim report is used to evaluate the firm's ability to meet its budgeted quality costs. Managers use the report to compare the actual quality costs with those that were targeted for the period.
- The multiple-period trend report is a trend graph for several years. The graph allows managers to assess the direction and magnitude of change since the inception of a total quality program.
- The long-range report compares actual costs with ideal or zero-defect level.

5. Discuss how environmental costs can be measured, reported, and reduced.

- Environmental costs are those costs incurred because poor environmental quality exists or may exist.
- There are four categories of environmental costs: prevention, detection, internal failure, and external failure.
- The external failure category is divided into realized and unrealized costs. Realized costs are those external costs the firm has to pay; unrealized or societal costs are those costs caused by the firm but paid for by society.
- An environmental cost report is prepared by listing costs for each item within the four environmental cost categories.

6. Show how environmental costs can be assigned to products and processes.

- Managers must decide whether they will assign only private costs or whether they want all costs to be assigned (full costing).
- ABC assigns costs to environmental activities and then calculates activity rates.
- ABC rates are then used to assign environmental costs to products.
- By assigning environmental cost to products, management can classify products according to their degree of "dirtiness."

CORNERSTONES FOR CHAPTER 16

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CORNERSTONE 16-2 The HOW and WHY of preparing interim quality performance reports, page 796

CORNERSTONE 16-3 The HOW and WHY of multiple-period quality trend reporting, page 798

CORNERSTONE 16-4 The HOW and WHY of long-range quality performance reporting, page 800

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Review Problems

I. Quality Cost Classification, Quality Improvement, and Profitability

At the beginning of the year, Kare Company initiated a quality improvement program. Considerable effort was expended to reduce the number of defective units produced. By the end of the year, reports from the production manager revealed that scrap and rework had both decreased. The president of the company was pleased to hear of the success but wanted some assessment of the financial impact of the improvements. To make this assessment, the following financial data were collected for the current and preceding years:

	Preceding Year (2012)	Current Year (2013)
Sales	$10,000,000	$10,000,000
Scrap	400,000	300,000
Rework	600,000	400,000
Product inspection	100,000	125,000
Product warranty	800,000	600,000
Quality training	40,000	80,000
Materials inspection	60,000	40,000

Required:

1. Classify the costs as prevention, appraisal, internal failure, or external failure.
2. Compute quality cost as a percentage of sales for each of the two years. By how much has profit increased because of quality improvements? Assuming that quality costs can be reduced to 2.5 percent of sales, how much additional profit is available through quality improvements (assume that sales revenues will remain the same)?

Solution:

1. Prevention costs: Quality training; Appraisal costs: Product inspection and materials inspection; Internal failure costs: Scrap and rework; External failure costs: Product warranty
2. *Preceding year*—Total quality costs: $2,000,000; percentage of sales: 20 percent ($2,000,000/$10,000,000). *Current year*—Total quality costs: $1,545,000; percentage of sales: 15.45 percent ($1,545,000/$10,000,000). Profit has increased by $455,000. If quality costs drop to 2.5 percent of sales, another $1,295,000 of profit improvement is possible ($1,545,000 – $250,000).

II. Environmental Costs

At the beginning of 2013, Vautrin Company initiated a program to improve its environmental performance. Efforts were made to reduce the production and emission of contaminating gaseous, solid, and liquid residues. By the end of the year, in an executive meeting, the environmental manager indicated that the company had made significant improvement in its environmental performance, reducing the emission of contaminating residues of all types. The president of the company was pleased with the reported success but wanted an assessment of the financial consequences of the environmental improvements. To satisfy this request, the following financial data were collected for 2012 and 2013 (all changes in cost are a product of environmental improvements):

	2012	2013
Sales	$60,000,000	$60,000,000
Evaluating and selecting suppliers	0	1,800,000
Treating and disposing of toxic materials	3,600,000	2,400,000
Inspecting processes (environmental objective)	600,000	900,000
Land restoration (annual fund contribution)	4,800,000	3,600,000
Maintaining pollution equipment	1,200,000	900,000
Testing for contaminants	450,000	300,000

Required:

1. Classify the costs as prevention, detection, internal failure, or external failure.
2. Prepare an environmental cost report for the most recent year, where costs are expressed as a percentage of sales (instead of operating costs).

Solution:

1. Prevention costs: Evaluating and selecting suppliers; Detection costs: Testing for contaminants and inspecting processes; Internal failure costs: Maintaining pollution equipment, and treating and disposing of toxic materials; External failure costs: Land restoration.

2.

Vautrin Company
Environmental Cost Report
For the Year Ended December 31, 2013

	Environmental Costs	Percentage of Sales
Prevention costs:		
Evaluating and selecting suppliers	$1,800,000	3.00%
Detection costs:		
Testing for contaminants	300,000	
Inspecting processes	900,000	
Total detection costs	1,200,000	2.00
Internal failure costs:		
Maintaining pollution equipment	900,000	
Treating and disposing of toxic materials	2,400,000	
Total internal failure costs	3,300,000	5.50
External failure costs:		
Land restoration	3,600,000	6.00
Total environmental costs	$9,900,000	16.50%

Key Terms

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Control activities, 783
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Discussion Questions

1. What is the difference between quality of design and quality of conformance?
2. Why are quality costs the costs of doing things wrong?
3. What is the difference between the zero-defects philosophy and the robust quality philosophy?
4. Describe the Taguchi quality loss function, and relate it to robust quality.
5. Identify and discuss the four kinds of quality costs.

6. Explain why external failure costs can be more devastating to a firm than internal failure costs.
7. Many quality experts maintain that quality is free. Do you agree or disagree? Why or why not?
8. What is the purpose of interim quality standards?
9. Describe the three types of quality performance reporting. How can managers use each report to help evaluate their quality improvement programs?
10. Discuss the different kinds of incentives that can be used to motivate employees to become involved in quality improvement programs. Explain gainsharing.
11. If a firm's annual sales are $200 million, what percentage of sales should be spent on quality costs? Suppose that the firm is spending 18 percent of sales on quality costs. What is the potential savings from quality improvement?
12. Explain why it is important for a manager to assess the relative distribution of quality costs among the four categories.
13. Discuss the benefits of quality cost reports that simply list the quality costs for each category.
14. Explain why the Accounting Department should be responsible for producing quality cost reports.
15. What is ISO 9000? Why do so many companies want this certification?
16. What is ecoefficiency?
17. What are the four objectives associated with ecoefficiency?
18. Describe the four opportunities for improving ecoefficiency.
19. What is an environmental cost?
20. What are the four categories of environmental costs? Define each category.
21. What is the difference between a realized external failure cost (environmental) and an unrealized external failure (societal) cost?
22. What does full environmental costing mean? Full private costing?
23. What information is communicated by the unit environmental cost of a product?

Cornerstone Exercises

Cornerstone Exercise 16-1 QUALITY COST REPORT

OBJECTIVE 1
CORNERSTONE 16-1
SERVICE

Black Company had total sales of $2,000,000 for fiscal 2013. The costs of quality-related activities are given below.

Returns/allowances	$100,000
Design changes	120,000
Prototype inspection	26,000
Downtime	80,000
Quality circles	4,000
Packaging inspection	28,000
Field testing	12,000
Complaint adjustment	130,000

Required:

1. Prepare a quality cost report, classifying costs by category and expressing each category as a percentage of sales. What message does the cost report provide?
2. Prepare a bar graph and pie chart that illustrate each category's contribution to total quality costs. Comment on the significance of the distribution.
3. ***What if*** five years from now, quality costs are 7.5 percent of sales, with control costs being 65 percent of the total quality costs? What would your conclusion be?

OBJECTIVE 3
CORNERSTONE 16-2
SERVICE

Cornerstone Exercise 16-2 INTERIM QUALITY PERFORMANCE REPORT

Harrison Inc. had the following quality costs for the years ended December 31, 2012 and 2013:

	2012	2013
Prevention costs:		
Quality audits	$ 20,000	$ 30,000
Vendor certification	40,000	60,000
Appraisal costs:		
Product acceptance	30,000	45,000
Process acceptance	25,000	36,500
Internal failure costs:		
Retesting	34,000	30,000
Rework	72,000	60,000
External failure costs:		
Recalls	50,000	40,000
Warranty	110,000	100,000

At the end of 2012, management decided to increase its investment in control costs by 50 percent for each category's items with the expectation that failure costs would decrease by 20 percent for each item of the failure categories. Sales were $4,000,000 for both 2012 and 2013:

Required:

1. Calculate the budgeted costs for 2013, and prepare an interim quality performance report.
2. Comment on the significance of the report. How much progress has Harrison made?
3. ***What if*** sales were $4,000,000 for 2012 and $5,000,000 for 2013? What adjustment to budgeted rework costs would be made? Budgeted quality audits? Assuming the actual costs for 2013 do not change, what does this adjustment say about Harrison's performance?

OBJECTIVE 3
CORNERSTONE 16-3
SERVICE

Cornerstone Exercise 16-3 QUALITY TREND REPORT

Leonardo Company implemented a quality improvement program and tracked the following for the five years:

	Quality Costs	Actual Sales	Costs as a Percentage of Sales
2009	$1,250,000	$5,000,000	25.00%
2010	1,237,500	5,500,000	22.50
2011	1,125,000	6,000,000	18.75
2012	1,085,000	6,200,000	17.50
2013	1,000,000	8,000,000	12.50

By cost category as a percentage of sales for the same period of time:

	Prevention	Appraisal	Internal Failure	External Failure
2009	2.50%	2.50%	7.50%	12.50%
2010	3.75	3.00	5.00	10.75
2011	3.75	3.75	3.75	7.50
2012	5.00	3.75	3.13	5.63
2013	5.10	3.00	2.50	1.90

Required:

1. Prepare a bar graph that reveals the trend in quality cost as a percentage of sales (time on the horizontal axis and percentages on the vertical). Comment on the message of the graph.
2. Prepare a bar graph for each cost category as a percentage of sales. What does this graph tell you?
3. ***What if*** management would like to have the trend in *relative* distribution of quality costs? Express this as a bar graph and comment on its significance.

Cornerstone Exercise 16-4 LONG-TERM PERFORMANCE REPORT

OBJECTIVE 3
CORNERSTONE 16-4
SERVICE

Cephalus Company had actual quality costs for the year ended June 30, 2013, as given below.

Prevention costs:	
Quality engineering	$ 120,000
Vendor certification	240,000
Total prevention costs	360,000
Appraisal costs:	
Packaging inspection	126,000
Test labour	144,000
Total appraisal costs	270,000
Internal failure costs:	
Retesting	75,000
Rework	150,000
Total internal failure costs	225,000
External failure costs:	
Recalls	97,500
Product liability	247,500
Total external failure costs	345,000
Total quality costs	$1,200,000

At the zero-defect state, Cephalus expects to spend $150,000 on quality engineering, $30,000 on vendor certification, and $20,000 on packaging inspection. Assume sales to be $10,000,000.

Required:

1. Prepare a long-range performance report for 2013. What does this report tell the management of Cephalus?
2. Explain why quality costs still are present for the zero-defect state.
3. ***What if*** Cephalus achieves the zero-defect state reflected in the report? What are some of the implications of this achievement?

Cornerstone Exercise 16-5 ENVIRONMENTAL COST REPORT

OBJECTIVE 5
CORNERSTONE 16-5
SERVICE

Greenbaum Company reported operating costs of $40,000,000 as of December 31, 2013, with the following environmental costs:

Testing for contamination	$ 560,000
Inspecting products	336,000
Treating toxic waste	1,680,000
Obtaining ISO 14001 certification	840,000
Designing processes	336,000
Cleaning up oil spills	2,940,000
Maintaining pollution equipment	1,000,000
Cleaning up contaminated soil	4,620,000

Required:

1. Prepare an environmental cost report, classifying costs by quality category and expressing each as a percentage of total operating costs. What is the message of this report?
2. Prepare a pie chart that shows the relative distribution of environmental costs by category. What does this report tell you?
3. ***What if*** Greenbaum deliberately did not include the cost of damaging the ecosystem because of solid waste disposal in its environmental cost report? Offer possible reasons for this decision. If consciously avoided, is this decision unethical?

OBJECTIVE 5

CORNERSTONE 16-6

Cornerstone Exercise 16-6 ACTIVITY-BASED ENVIRONMENTAL COST ASSIGNMENTS

Liang Inc. had the following environmental activities and product information:

1. Environmental activity costs

Activity	Costs
Design products (to reduce pollution)	$ 180,000
Test for contamination	320,000
Treat toxic waste	1,000,000
Operate pollution control equipment	800,000

2. Driver data

	Solvent X	Solvent Y
Design hours	4,000	2,000
Testing hours	7,000	9,000
Kilograms of waste	800	19,200
Machine hours	4,000	76,000

3. Other production data

	Solvent X	Solvent Y
Nonenvironmental production costs	$3,360,000	$6,520,000
Units produced	400,000	400,000

Required:

1. Calculate the activity rates that will be used to assign environmental costs to products.
2. Determine the unit environmental and unit costs of each product using ABC.
3. ***What if*** the design costs increased to $240,000 and the cost of toxic waste decreased to $500,000? Assume that Solvent Y uses 4,000 out of 8,000 design hours. Also assume that waste is cut by 50 percent and that Solvent Y is responsible for 19,000 of 20,000 kilograms of toxic waste. What is the new environmental cost for Solvent Y?

Exercises

OBJECTIVE 1

Exercise 16-7 QUALITY DEFINITION AND QUALITY COSTS

Rachel Greco, president of a company that manufactures electronic components, has a number of questions concerning quality and quality costs. She has heard a few things about quality and has asked you to respond to the following:

Required:

1. What does it mean to have a quality product or service? Explain how product quality and conformance are related.
2. Yesterday, my quality manager told me that we need to redefine what we mean by a defective product. He said that conforming to specifications ignores the cost of product variability and that further reduction of product variability is a veritable gold mine—just waiting to be mined. What did he mean?

OBJECTIVE 1

SERVICE

Exercise 16-8 QUALITY DEFINITION AND QUALITY COSTS

Quality attributes such as performance and aesthetics are important to customers. Performance refers to how consistently and how well a product functions. Aesthetics is concerned with the appearance of tangible products as well as the appearance of the facilities, equipment, personnel, and communication materials associated with services.

Required:

1. Do you agree that aesthetics is an important quality dimension for services? Use dental services as the framework for providing your response.

2. For services, performance can be more carefully defined by expanding its definition to include responsiveness, assurance, and empathy. Describe what you think is meant by these three characteristics as applied to service quality.

Exercise 16-9 TAGUCHI LOSS FUNCTION

OBJECTIVE 1

Mukarjee Company estimates its hidden external failure costs using the Taguchi loss function. Mukarjee produces plastic sheets that vary in thickness and grade. For one of its large-volume products, it was determined that $k = \$200$ and $T = 2.5$ centimetres in diameter. A sample of four units produced the following values:

Unit No.	Actual Diameter (cm)
1	2.5
2	2.7
3	2.3
4	2.4

Required:

1. Calculate the average loss per unit.
2. Assuming that 50,000 units were produced, what is the total hidden cost?
3. Assume that the multiplier for Milton's hidden external failure costs is five. What are the measured external costs? Explain the difference between measured costs and hidden costs.

Exercise 16-10 QUALITY COST CLASSIFICATION

OBJECTIVE 1

SERVICE

Classify the following quality costs as prevention costs, appraisal costs, internal failure costs, or external failure costs:

1. Inspection of reworked units
2. Inspecting and testing a newly developed product (not yet being sold)
3. Retesting a reworked product
4. Repairing a computer still under warranty
5. Discount allowed to customers because products failed to meet customer specifications
6. Goods returned because they failed to meet specifications
7. The cost of evaluating and certifying suppliers
8. Stopping work to correct process malfunction (discovered using statistical process control procedures)
9. Testing products in the field
10. Discarding products that cannot be reworked
11. Lost sales because of recalled products
12. Inspection of incoming materials
13. Redesigning a product to eliminate the need to use an outside component with a high defect rate
14. Purchase order changes
15. Replacing a defective product
16. Inspecting and testing prototypes
17. Repairing products in the field
18. Correcting a design error discovered during product development
19. Engineering resources used to help selected suppliers improve their product quality
20. Packaging inspection
21. Processing and responding to consumer complaints
22. Training production line workers in new quality procedures
23. Sampling a batch of goods to determine if the batch has an acceptable defect rate

Exercise 16-11 ACTIVITY-BASED QUALITY COSTING

OBJECTIVE 1 2

Simone Company produces two different carburetors and is concerned about their quality. The company has identified the following quality activities and costs associated with the two products:

	Carburetor A	Carburetor B
Units produced	340,000	680,000
Warranty work (units)	1,700	850
Scrapped units (number)	3,400	850
Inspection (hours)	3,400	1,700
Quality training (hours)	85	85
Activities:		
Performing warranty work	$408,000	
Scrapping units	306,000	
Inspecting	153,000	
Quality training	95,000	

Required:

1. Calculate the quality cost per unit for each product, and break this unit cost into quality cost categories. Which of the two seems to have the lowest quality?
2. How might a manager use the unit quality cost information?

OBJECTIVE 2

Exercise 16-12 QUALITY COST REPORT

Benton Company reported sales of $8,100,000 in 2013. At the end of the calendar year, the following quality costs were reported:

Design review	$405,000
Recalls	135,000
Reinspection	67,500
Materials inspection	54,000
Quality training	135,000
Process acceptance	67,500
Scrap	47,250
Lost sales	270,000
Product inspection	40,500
Returned goods	128,250

Required:

1. Prepare a quality cost report.
2. Prepare a graph (pie chart or bar graph) that shows the relative distribution of quality costs, and comment on the distribution.

OBJECTIVE 2 3

SERVICE

Exercise 16-13 QUALITY IMPROVEMENT AND PROFITABILITY

Reading Company reported the following sales and quality costs for the past four years. Assume that all quality costs are variable and that all changes in the quality cost ratios are due to a quality improvement program.

Year	Sales Revenues	Quality Costs as a Percent of Revenues
1	$10,000,000	21%
2	11,000,000	18
3	11,000,000	14
4	12,000,000	10

Required:

1. Compute the quality costs for all four years. By how much did net income increase from Year 1 to Year 2 because of quality improvements? From Year 2 to Year 3? From Year 3 to Year 4?
2. The management of Reading Company believes it is possible to reduce quality costs to 2.5 percent of sales. Assuming sales will continue at the Year 4 level, calculate the additional profit potential facing Reading. Is the expectation of improving quality and reducing costs to 2.5 percent of sales realistic? Explain.
3. Assume that Reading produces one type of product, which is sold on a bid basis. In Years 1 and 2, the average bid was $200. In Year 1, total variable costs were $125

per unit. In Year 3, competition forced the bid to drop to $190. Compute the total contribution margin in Year 3 assuming the same quality costs as in Year 1. Now, compute the total contribution margin in Year 3 using the actual quality costs for Year 3. What is the increase in profitability resulting from the quality improvements made from Year 1 to Year 3?

Exercise 16-14 QUALITY COSTS: PROFIT IMPROVEMENT AND DISTRIBUTION ACROSS CATEGORIES, GAINSHARING

OBJECTIVE 2 3 4

Sioux Company had sales of $30,000,000 in 2009. In 2013, sales had increased to $37,500,000. A quality improvement program was implemented at the beginning of 2009. Overall conformance quality was targeted for improvement. The quality costs for 2009 and 2013 follow. Assume any changes in quality costs are attributable to improvements in quality.

	2009	2013
Internal failure costs	$2,250,000	$112,500
External failure costs	3,000,000	75,000
Appraisal costs	1,350,000	281,250
Prevention costs	900,000	468,750
Total quality costs	$7,500,000	$937,500

Required:

1. Compute the quality cost-to-sales ratio for each year. Is this type of improvement possible?
2. Calculate the relative distribution of costs by category for 2009. What do you think of the way costs are distributed? (A pie chart or bar graph may be of some help.) How do you think they will be distributed as the company approaches a zero-defects state?
3. Calculate the relative distribution of costs by category for 2013. What do you think of the level and distribution of quality costs? (A pie chart or bar graph may be of some help.) Do you think further reductions are possible?
4. The quality manager for Sioux indicated that the external failure costs reported are only the measured costs. He argued that the 2013 external costs were much higher than those reported and that additional investment ought to be made in control costs. Discuss the validity of his viewpoint.
5. Suppose that the manager of Sioux received a bonus equal to 10 percent of the quality cost savings each year. Do you think that gainsharing is a good or a bad idea? Discuss the risks of gainsharing.

Exercise 16-15 TRADE-OFFS AMONG QUALITY COST CATEGORIES, TOTAL QUALITY CONTROL, GAINSHARING

OBJECTIVE 2 4

Javier Company has sales of $8 million and quality costs of $1,600,000. The company is embarking on a major quality improvement program. During the next three years, Javier intends to attack failure costs by increasing its appraisal and prevention costs. The "right" prevention activities will be selected, and appraisal costs will be reduced according to the results achieved. For the coming year, management is considering six specific activities: quality training, process control, product inspection, supplier evaluation, prototype testing, and redesign of two major products. To encourage managers to focus on reducing non-value-added quality costs and select the right activities, a bonus pool is established relating to reduction of quality costs. The bonus pool is equal to 10 percent of the total reduction in quality costs.

Current quality costs and the costs of these six activities are given in the following table. Each activity is added sequentially so that its effect on the cost categories can be assessed. For example, after quality training is added, the control costs increase to $320,000, and the failure costs drop to $1,040,000. Even though the activities are presented sequentially, they are totally independent of one another. Thus, only beneficial activities need be selected.

	Control Costs	Failure Costs
Current quality costs	$ 160,000	$1,440,000
Quality training	320,000	1,040,000
Process control	520,000	720,000
Product inspection	600,000	656,000
Supplier evaluation	720,000	200,000
Prototype testing	960,000	120,000
Engineering redesign	1,000,000	40,000

Required:

1. Identify the control activities that should be implemented, and calculate the total quality costs associated with this selection. Assume that an activity is selected only if it increases the bonus pool.
2. Given the activities selected in Requirement 1, calculate the following:
   a. The reduction in total quality costs
   b. The percentage distribution for control and failure costs
   c. The amount for this year's bonus pool
3. Suppose that a quality engineer complained about the gainsharing incentive system. Basically, she argued that the bonus should be based only on reductions of failure and appraisal costs. In this way, investment in prevention activities would be encouraged, and eventually, failure and appraisal costs would be eliminated. After eliminating the non-value-added costs, focus could then be placed on the level of prevention costs. If this approach were adopted, what activities would be selected? Do you agree or disagree with this approach? Explain.

OBJECTIVE 4

Exercise 16-16 TREND, LONG-RANGE PERFORMANCE REPORT

SERVICE

In 2012, Tru-Delite Frozen Desserts Inc. instituted a quality improvement program. At the end of 2013, the management of the corporation requested a report to show the amount saved by the measures taken during the year. The actual sales and quality costs for 2012 and 2013 are as follows:

	2012	2013
Sales	$600,000	$600,000
Scrap	15,000	15,000
Rework	20,000	10,000
Training program	5,000	6,000
Consumer complaints	10,000	5,000
Lost sales, incorrect labelling	8,000	—
Test labour	12,000	8,000
Inspection labour	25,000	24,000
Supplier evaluation	15,000	13,000

Tru-Delite's management believes that quality costs can be reduced to 2.5 percent of sales within the next five years. At the end of 2018, Tru-Delite's sales are projected to grow to $750,000. The projected relative distribution of quality costs at the end of 2018 is as follows:

Scrap	15%
Training program	20
Supplier evaluation	25
Test labour	25
Inspection labour	15
Total quality costs	100%

Required:

1. Profits increased by what amount due to quality improvements made in 2013?
2. Prepare a long-range performance report that compares the quality costs incurred at the end of 2013 with the quality cost structure expected at the end of 2018.

3. Are the targeted costs in the year 2018 all value-added costs? How would you interpret the variances if the targeted costs are value-added costs?
4. What would be the profit increase in 2018 if the 2.5 percent performance standard is met in that year?

Exercise 16-17 MULTIPLE-YEAR TREND REPORTS

OBJECTIVE 4

The controller of Willson Company has computed quality costs as a percentage of sales for the past five years (2009 was the first year the company implemented a quality improvement program). This information is as follows:

	Prevention	Appraisal	Internal Failure	External Failure	Total
2009	2%	3%	8.0%	12%	25.0%
2010	3	4	7.0	10	24.0
2011	4	5	5.5	6	20.5
2012	5	4	3.0	5	17.0
2013	6	3	1.0	2	12.0

Required:

1. Prepare a trend graph for total quality costs. Comment on what the graph has to say about the success of the quality improvement program.
2. Prepare a graph that shows the trend for each quality cost category. What does the graph have to say about the success of the quality improvement program? Does this graph supply more insight than the total cost trend graph does?
3. Prepare a graph that compares the trend in relative quality costs. What does this graph tell you?

Exercise 16-18 ECOEFFICIENCY

OBJECTIVE 5

For years, companies dealt with pollution problems through compliance management (ensuring that a company follows environmental laws and regulations as cheaply as possible). No effort was made to improve environmental performance beyond the minimal performance that satisfied environmental regulations (improving environmental performance and increasing economic efficiency were viewed as incompatible objectives). Recently, two alternative views of managing environmental cost have been proposed: (1) ecoefficiency and (2) guided ecoefficiency.

Required:

1. Explain why ecoefficiency may be a better view of the world than that espoused by compliance management. Discuss factors that may support this view.
2. Some believe that even if the ecoefficient view is true, regulatory intervention still may be needed. The type of intervention, however, must be carefully designed. Explain what is meant by properly designed regulation, and identify the key assumptions that must hold for the guided ecoefficiency view to be valid.

Exercise 16-19 ECOEFFICIENCY AND SUSTAINABLE DEVELOPMENT

OBJECTIVE 5

SERVICE

Achieving sustainable development will likely require the cooperation of communities, governments, and businesses. The World Business Council for Sustainable Development (WBCSD) claims that ecoefficiency is "the business contribution to sustainable development."

Required:

1. What is sustainable development?
2. Explain why the WBCSD's claim about ecoefficiency may be true.
3. WBCSD has noted (http://www.wbcsd.org): "the good news is that ecoefficiency is working in the companies that try it. The troubling news is that it is not being tried on a large enough scale, even though it makes good business sense." Why do you think the ecoefficiency paradigm is not as widely accepted as it perhaps ought to be? What would you suggest to increase the number of companies involved in ecoefficient projects?

OBJECTIVE 5

SERVICE

Exercise 16-20 CLASSIFICATION OF ENVIRONMENTAL COSTS

Classify the following environmental activities as prevention costs, detection costs, internal failure costs, or external failure costs. For external failure costs, classify the costs as societal or private. Also, label those activities that are compatible with sustainable development (SD).

1. A company takes actions to reduce the amount of material in its packages.
2. After the activated carbon's useful life, a soft-drink producer returns this material used for purifying water for its beverages to the supplier. The supplier reactivates the carbon for a second use in nonfood applications. As a consequence, many tonnes of material are prevented from entering landfills.
3. An evaporator system is installed to treat wastewater and collect usable solids for other uses.
4. The inks used to print snack packages (for chips) contain heavy metals.
5. Processes are inspected to ensure compliance with environmental standards.
6. Delivery boxes are used five times and then recycled. This prevents 112 million kilograms of cardboard from entering landfills and saves 2 million trees per year.
7. Scrubber equipment is installed to ensure that air emissions are less than the level permitted by law.
8. Local residents are incurring medical costs from illnesses caused by air pollution from automobile exhaust pollution.
9. As part of implementing an environmental perspective for the Balanced Scorecard, environmental performance measures are developed.
10. Because of liquid and solid residues being discharged into a local lake, the lake is no longer fit for swimming, fishing, and other recreational activities.
11. To reduce energy consumption, magnetic ballasts are replaced with electronic ballasts, and more efficient light bulbs and lighting sensors are installed. As a result, 2.3 million kilowatt-hours of electricity are saved per year.
12. Due to a legal settlement, a chemicals company must spend $20 million to clean up contaminated soil.
13. A soft-drink company uses the following practice: In all bottling plants, packages damaged during filling are collected and recycled (glass, plastic, and aluminum).
14. Products are inspected to ensure that the gaseous emissions produced during operation follow legal and company guidelines.
15. The cost of operating pollution control equipment.
16. An internal audit is conducted to verify that environmental policies are being followed.

OBJECTIVE 5

Exercise 16-21 ENVIRONMENTAL COST REPORT

At the end of 2013, Sarnia Chemicals began to implement an environmental quality management program. As a first step, it identified the following costs in its accounting records as environmentally related for the calendar year just ended:

	2013
Settling personal injury claims	$1,200,000
Treating and disposing of toxic waste	4,800,000
Cleanup of chemically contaminated soil	1,800,000
Inspecting products and processes	600,000
Operating pollution control equipment	840,000
Licensing facilities for producing contaminants	360,000
Evaluating and selecting suppliers	120,000
Developing performance measures	60,000
Recycling products	75,000

Required:

1. Prepare an environmental cost report by category. Assume that total operating costs are $60 million.
2. Use a pie chart to illustrate the relative distribution percentages for each environmental cost category. Comment on what this distribution communicates to a manager.

Exercise 16-22 REPORTING SOCIAL COSTS

OBJECTIVE 5

Refer to **Exercise 16-21**. Suppose that the newly hired environmental manager examines the report and makes the following comment: "This report understates the total environmental costs. It fails to consider the costs we are imposing on the local community. For example, we have polluted the river and lake so much that swimming and fishing are no longer possible. I have heard rumblings from the local citizens, and I'll bet that we will be facing a big cleanup bill in a few years."

Subsequent to the comment, environmental engineering estimated that cleanup costs for the river and lake will cost $3 million, assuming the cleanup efforts are required within five years. To pay for the cleanup, annual contributions of $525,000 will be invested with the expectation that the fund will grow to $3 million by the end of the fifth year. Assume also that the loss of recreational opportunities is costing the local community $1.2 million per year.

Required:

1. How would this information alter the report in **Exercise 16-21**?
2. Current financial reporting standards require that contingent liabilities be disclosed if certain conditions are met. Thus, it is possible that Sarnia may need to disclose the $3 million cleanup liability. Yet, the opportunity cost for the recreational opportunities need not be disclosed to outside parties. Should Sarnia voluntarily disclose this cost? Is it likely that it would?

Exercise 16-23 ENVIRONMENTAL COST ASSIGNMENT

OBJECTIVE 2

Algos Pharmaceuticals produces two organic chemicals (Org AB and Org XY) used in the production of two of its most wide-selling anti-cancer drugs. The controller and environmental manager have identified the following environmental activities and costs associated with the two products:

	Org AB	Org XY
Kilograms produced	7,500,000	18,750,000
Packaging materials (kilograms)	2,250,000	1,125,000
Energy usage (kilowatt-hours)	750,000	375,000
Toxin releases (kilograms into air)	1,875,000	375,000
Pollution control (machine hours)	300,000	75,000
Costs of activities:		
Using packaging materials	$3,375,000	
Using energy	900,000	
Releasing toxins (fines)	450,000	
Operating pollution control equipment	1,050,000	

Required:

1. Calculate the environmental cost per kilogram for each product. Which of the two products appears to cause the most degradation to the environment?
2. In which environmental category would you classify excessive use of materials and energy?
3. Suppose that the toxin releases cause health problems for those who live near the chemical plant. The costs, due to missed work and medical treatments, are estimated at $2,025,000 per year. How would assignment of these costs change the unit cost? Should they be assigned?

Exercise 16-24 ENVIRONMENTAL COSTING, ECOEFFICIENCY, AND COMPETITIVE ADVANTAGE

OBJECTIVE 5 6

Refer to the data in **Exercise 16-23**. Suppose that Algos's manager decides to launch an environmental performance improvement program. First, efforts were made to reduce the amount of packaging. The demand for packaging materials was reduced by 10 percent. Second, a way was found to reuse the packaging materials. Usage of packaging materials changed from one time to two times. Both changes together saved $1,856,250 in packaging costs. Third, the manufacturing processes were redesigned to produce a

reduced environmental load. The new processes were able to reduce emissions by 50 percent and private emission costs by 75 percent. The new processes also reduced the demand for energy by one-third. Energy costs were also reduced by the same amount. There was no change in the demand or cost of operating pollution control equipment.

The cost of implementing the changes was $753,750 (salaries of $450,000 for hiring six environmental engineers and $303,750 for treating the packaging materials so they can be reused). Engineering hours used for each process are 11,250 for the Org AB process and 3,750 for the Org XY process.

Required:

1. Calculate the new cost per kilogram for each product. Assume that the environmental reductions for each product are in the same proportions as the total reductions.
2. Calculate the net savings produced by the environmental changes for each product, in total, and on a per-unit basis. Does this support the concept of ecoefficiency?
3. Classify the activities as prevention, detection, internal failure, or external failure.
4. Describe how the environmental improvements can contribute to improving the firm's competitive position.

Problems

OBJECTIVE 1 2

SERVICE

Problem 16-25 QUALITY COST REPORT, TAGUCHI LOSS FUNCTION

Marlene Briggs, president of Shorts Company, was concerned with the trend in sales and profitability. The company had been losing customers at an alarming rate. Furthermore, the company was barely breaking even. Investigation revealed that poor quality was at the root of the problem. At the end of 2013, Marlene decided to begin a quality improvement program. As a first step, she identified the following in the accounting records as quality related, in addition to the sales revenue:

	2013
Sales (400,000 units @ $100)	$40,000,000
Reinspection	1,200,000
Downtime (due to defects)	1,600,000
Vendor certification	480,000
Consumer complaints	800,000
Warranty	1,600,000
Test labour	1,200,000
Inspection labour	1,000,000
Design reviews	120,000

Required:

1. Prepare a quality cost report by quality cost category.
2. Calculate the relative distribution percentages for each quality cost category. Comment on the distribution.
3. Using the Taguchi loss function, an average loss per unit is computed to be $15 per unit. What are the hidden costs of external failure? How does this affect the relative distribution?
4. Shorts's quality manager decided not to bother with the hidden costs. He reasoned that any efforts to reduce measured external failure costs will also reduce the hidden costs. Do you agree or disagree? Explain.

OBJECTIVE 2

Problem 16-26 TAGUCHI LOSS FUNCTION

Timpano Company manufactures a component for small portable DVD players (designed for use on automobile trips). Weight and durability of the component are the two most important quality characteristics for the DVD manufacturers. With respect to the weight dimension, the component has a target value of 240 grams. Specification limits are 240 grams, plus or minus 10 grams. Products produced at the lower specification

limit of 230 grams lose $40. A sample of five units produced the following weight measures:

Unit No.	Measured Weight
1	250
2	260
3	270
4	220
5	225

During the first quarter, 100,000 units were produced.

Required:

1. Calculate the loss for each unit. Calculate the average loss for the sample of five.
2. Using the average loss, calculate the hidden quality costs for the first quarter.
3. Durability is another important quality characteristic. The target value is 18,000 hours of operation before failure. The lower specification limit set by engineering and marketing is 17,000 hours. They agreed that there should be no upper specification limit. They also noted that there is a $750 loss at the lower specification limit. Explain why there would be no upper specification limit. Use the lower limit and the *left half* of the Taguchi quadratic loss function to estimate the loss for components with the following lives: 4,500 hours, 9,000 hours, and 13,500 hours. What does this reveal about the importance of durability?

Problem 16-27 QUALITY COSTS, PRICING DECISIONS, MARKET SHARE

OBJECTIVE 3

Gaston Company manufactures furniture. One of its product lines is an economy-line kitchen table. During the past year, Gaston produced and sold 100,000 units for $100 per unit. Sales of the table are on a bid basis, but Gaston has always been able to win sufficient bids using the $100 price. This year, however, Gaston was losing more than its share of bids. Concerned, Leo Leonisky, owner and president of the company, called a meeting of his executive committee (Megan Johnson, marketing manager; Fred Davis, quality manager; Kahil Muhamed, production manager; and Helen Jackson, controller).

LEO: I don't understand why we're losing bids. Megan, do you have an explanation?

MEGAN: Yes, as a matter of fact. Two competitors have lowered their price to $92 per unit. That's too big a difference for most of our buyers to ignore. If we want to keep selling our 100,000 units per year, we will need to lower our price to $92. Otherwise, our sales will drop to about 20,000 to 25,000 per year.

HELEN: The unit contribution margin on the table is $10. Lowering the price to $92 will cost us $8 per unit. Based on a sales volume of 100,000, we'd make $200,000 in contribution margin. If we keep the price at $100, our contribution margin would be $200,000 to $250,000. If we have to lose, let's just take the lower market share. It's better than lowering our prices.

MEGAN: Perhaps. But the same thing could happen to some of our other product lines. My sources tell me that these two companies are on the tail-end of a major quality improvement program—one that allows them significant savings. We need to rethink our whole competitive strategy—at least if we want to stay in business. Ideally, we should match the price reduction and work to reduce the costs to recapture the lost contribution margin.

FRED: I think I have something to offer. We are about to embark on a new quality improvement program of our own. I have brought the following estimates of the current quality costs for this economy line. As you can see, these costs run about 16 percent of current sales. That's excessive, and we believe that they can be reduced to about 4 percent of sales over time.

Scrap	$ 700,000
Rework	300,000
Rejects (sold as seconds to discount houses)	250,000
Returns (due to poor workmanship)	350,000
	$1,600,000

LEO: This sounds good. Fred, how long will it take for you to achieve this reduction?

FRED: All these costs vary with sales level, so I'll express their reduction rate in those terms. Our best guess is that we can reduce these costs by about 1 percent of sales per quarter. So it should take about 12 quarters, or three years, to achieve the full benefit. Keep in mind that this is with an improvement in quality.

MEGAN: This offers us some hope. If we meet the price immediately, we can maintain our market share. Furthermore, if we can ever reach the point of reducing the price below the $92 level, then we can increase our market share. I estimate that we can increase sales by about 10,000 units for every $1 of price reduction beyond the $92 level. Kahil, how much extra capacity for this line do we have?

KAHIL: We can handle an extra 30,000 or 40,000 tables per year.

Required:

1. Assume that Gaston immediately reduces the bid price to $92. How long will it be before the unit contribution margin is restored to $10, assuming that quality costs are reduced as expected and that sales are maintained at 100,000 units per year (25,000 per quarter)?
2. Assume that Gaston holds the price at $92 until the 4 percent target is achieved. At this new level of quality costs, should the price be reduced? If so, by how much should the price be reduced, and what is the increase in contribution margin? Assume that price can be reduced only in $1 increments.
3. Assume that Gaston immediately reduces the price to $92 and begins the quality improvement program. Now, suppose that Gaston does not wait until the end of the three-year period before reducing prices further. Instead, prices will be reduced when profitable to do so. Assume that prices can be reduced only by $1 increments. Identify when the first future price change should occur (if any).
4. Discuss the differences in viewpoints concerning the decision to decrease prices and the short-run contribution margin analysis done by Helen, the controller. Did quality cost information play an important role in the strategic decision making illustrated by the problem?

OBJECTIVE 1

SERVICE

Problem 16-28 CLASSIFICATION OF QUALITY COSTS

Classify the following quality costs as prevention, appraisal, internal failure, or external failure. Also, label each cost as variable or fixed with respect to sales volume.

1. Quality engineering
2. Scrap
3. Product recalls
4. Returns and allowances because of quality problems
5. Sales data re-entered because of keying errors
6. Supervision of in-process inspection
7. Quality circles
8. Component inspection and testing
9. Quality training
10. Reinspection of reworked product
11. Product liability
12. Internal audit assessing the effectiveness of quality system
13. Disposal of defective product
14. Downtime attributable to quality problems
15. Quality reporting
16. Proofreading

17. Correction of typing errors
18. In-process inspection
19. Process controls
20. Pilot studies

Problem 16-29 QUALITY COST SUMMARY

OBJECTIVE 2

Ernesto Rodriguez, president of Banshee Company, recently returned from a conference on quality and productivity. At the conference, he was told that many Canadian firms have quality costs totalling 20 to 30 percent of sales. He, however, was skeptical about this statistic. But even if the quality gurus were right, he was sure that his company's quality costs were much lower—probably less than 5 percent. On the other hand, if he was wrong, he would be passing up an opportunity to improve profits significantly and simultaneously strengthen his competitive position. The possibility was at least worth exploring. He knew that his company produced most of the information needed for quality cost reporting—but there never was a need to bother with any formal quality data gathering and analysis.

This conference, however, had convinced him that a firm's profitability can increase significantly by improving quality—provided the potential for improvement exists. Thus, before committing the company to a quality improvement program, Ernesto requested a preliminary estimate of the total quality costs currently being incurred. He also indicated that the costs should be classified into four categories: prevention, appraisal, internal failure, or external failure. He has asked you to prepare a summary of quality costs and to compare the total costs to sales and profits. To assist you in this task, the following information has been prepared from the past year, 2013:

a. Sales revenue, $15,000,000; net income, $1,500,000.
b. During the year, customers returned 90,000 units needing repair. Repair cost averages $1 per unit.
c. Four inspectors are employed, each earning an annual salary of $60,000. These four inspectors are involved only with final inspection (product acceptance).
d. Total scrap is 150,000 units. Of this total, 60 percent is quality related. The cost of scrap is about $5 per unit.
e. Each year, approximately 450,000 units are rejected in final inspection. Of these units, 80 percent can be recovered through rework. The cost of rework is $0.75 per unit.
f. A customer cancelled an order that would have increased profits by $150,000. The customer's reason for cancellation was poor product performance.
g. The company employs three full-time employees in its complaint department. Each earns $40,500 a year.
h. The company gave sales allowances totalling $45,000 due to substandard products being sent to the customer.
i. The company requires all new employees to take its three-hour quality training program. The estimated annual cost of the program is $30,000.

Required:

1. Prepare a simple quality cost report classifying costs by category.
2. Compute the quality cost-sales ratio. Also, compare the total quality costs with total profits. Should Ernesto be concerned with the level of quality costs?
3. Prepare a pie chart for the quality costs. Discuss the distribution of quality costs among the four categories. Are they properly distributed? Explain.
4. Discuss how the company can improve its overall quality and at the same time reduce total quality costs.
5. By how much will profits increase if quality costs are reduced to 2.5 percent of sales?

Problem 16-30 QUALITY COST REPORT, INTERIM PERFORMANCE REPORT

OBJECTIVE 1 2 4

Recently, Ulrich Company received a report from an external consulting group on its quality costs. The consultants reported that the company's quality costs total about 21 percent of its sales revenues. Somewhat shocked by the magnitude of the costs, Rob

(continued)

Rustin, president of Ulrich Company, decided to launch a major quality improvement program. For the coming year, management decided to reduce quality costs to 17 percent of sales revenues. Although the amount of reduction was ambitious, most company officials believed that the goal could be realized. To improve the monitoring of the quality improvement program, Rob directed Lena Skouri, the controller, to prepare quarterly performance reports comparing budgeted and actual quality costs. Budgeted costs and sales for the first two months of the year are as follows:

	January	February
Sales	$500,000	$600,000
Quality costs:		
Warranty	$ 15,000	$ 18,000
Scrap	10,000	12,000
Incoming materials inspection	2,500	2,500
Product acceptance	13,000	15,000
Quality planning	2,000	2,000
Field inspection	12,000	14,000
Retesting	6,000	7,200
Allowances	7,500	9,000
New product review	$ 500	$ 500
Rework	9,000	10,800
Complaint adjustment	2,500	2,500
Downtime (defective parts)	5,000	6,000
Quality training	1,000	1,000
Total budgeted costs	$ 86,000	$100,500
Quality costs-sales ratio	17.2%	16.75%

The following actual sales and actual quality costs were reported for January:

Sales	$550,000
Quality costs:	
Warranty	17,500
Scrap	12,500
Incoming materials inspection	2,500
Product acceptance	14,000
Quality planning	2,500
Field inspection	14,000
Retesting	7,000
Allowances	8,500
New product review	700
Rework	11,000
Complaint adjustment	2,500
Downtime (defective parts)	5,500
Quality training	1,000

Required:

1. Reorganize the monthly budgets so that quality costs are grouped in one of four categories: appraisal, prevention, internal failure, or external failure. (Essentially, prepare a budgeted cost of quality report.) Also, identify each cost as variable (V) or fixed (F). (Assume that no costs are mixed.)
2. Prepare a performance report for January that compares actual costs with budgeted costs. Comment on the company's progress in improving quality and reducing its quality costs.

OBJECTIVE 4

SERVICE

Problem 16-31 QUALITY COST PERFORMANCE REPORTING: ONE-YEAR TREND, LONG-RANGE ANALYSIS

In 2013, Major Company initiated a full-scale, quality improvement program. At the end of the year, Jack Aldredge, the president, noted with some satisfaction that the defects per unit of product had dropped significantly compared to the prior year. He was

also pleased that relationships with suppliers had improved and defective materials had declined. The new quality training program was also well accepted by employees. Of most interest to the president, however, was the impact of the quality improvements on profitability. To help assess the dollar impact of the quality improvements, the actual sales and the actual quality costs for 2012 and 2013 are as follows by quality category:

	2012	2013
Sales	$8,000,000	$10,000,000
Appraisal costs:		
Packaging inspection	320,000	300,000
Product acceptance	40,000	28,000
Prevention costs:		
Quality circles	4,000	40,000
Design reviews	2,000	20,000
Quality improvement projects	2,000	100,000
Internal failure costs:		
Scrap	$ 280,000	$ 240,000
Rework	360,000	320,000
Yield losses	160,000	100,000
Retesting	200,000	160,000
External failure costs:		
Returned materials	160,000	160,000
Allowances	120,000	140,000
Warranty	400,000	440,000

All prevention costs are fixed (by discretion). Assume all other quality costs are unit-level variable.

Required:

1. Compute the relative distribution of quality costs for each year and prepare a pie chart. Do you believe that the company is moving in the right direction in terms of the balance among the quality cost categories? Explain.
2. Prepare a one-year trend performance report for 2013 (compare the actual costs of 2013 with those of 2012, adjusted for differences in sales volume). How much have profits increased because of the quality improvements made by Major Company?
3. Estimate the additional improvement in profits if Major Company ultimately reduces its quality costs to 2.5 percent of sales revenues (assume sales of $10 million).

Problem 16-32 DISTRIBUTION OF QUALITY COSTS

OBJECTIVE 2

Paper Products Division produces paper diapers, napkins, and paper towels. The divisional manager has decided that quality costs can be minimized by distributing quality costs evenly among the four quality categories and reducing them to no more than 5 percent of sales. He has just received the following quality cost report:

Paper Products Division
Quality Cost Report
For the Year Ended December 31, 2013

	Diapers	Napkins	Paper Towels	Total
Prevention costs:				
Quality training	$ 3,000	$ 2,500	$ 2,000	$ 7,500
Quality engineering	3,500	1,000	2,500	7,000
Quality audits	—	500	1,000	1,500
Quality reporting	2,500	2,000	1,000	5,500
Total prevention costs	9,000	6,000	6,500	21,500

	Diapers	Napkins	Paper Towels	Total
Appraisal costs:				
Inspection, materials	2,000	3,000	3,000	8,000
Process acceptance	4,000	2,800	1,200	8,000
Product acceptance	2,000	1,200	2,300	5,500
Total appraisal costs	8,000	7,000	6,500	21,500
Internal failure costs:				
Scrap	10,000	3,000	2,500	15,500
Disposal costs	7,000	2,000	1,500	10,500
Downtime	1,000	1,500	2,500	5,000
Total internal failure costs	18,000	6,500	6,500	31,000
External failure costs:				
Allowances	10,000	3,000	2,750	15,750
Customer complaints	4,000	1,500	3,750	9,250
Product liability	1,000	—	—	1,000
Total external failure costs	15,000	4,500	6,500	26,000
Total quality costs	$50,000	$24,000	$26,000	$100,000

Assume that all prevention costs are fixed and that the remaining quality costs are variable (unit-level).

Required:

1. Assume that the sales revenue for the year totalled $2 million, with sales for each product as follows: diapers, $1 million; napkins, $600,000; paper towels, $400,000. Evaluate the distribution of costs for the division as a whole and for each product line. What recommendations do you have for the divisional manager?
2. Now, assume that total sales are $1 million and have this breakdown: diapers, $500,000; napkins, $300,000; paper towels, $200,000. Evaluate the distribution of costs for the division as a whole and for each product line in this case. Do you think it is possible to reduce the quality costs to 5 percent of sales for each product line and for the division as a whole and, simultaneously, achieve an equal distribution of the quality costs? What recommendations do you have?
3. Assume total sales of $1 million with this breakdown: diapers, $500,000; napkins, $180,000; paper towels, $320,000. Evaluate the distribution of quality costs. What recommendations do you have for the divisional manager?
4. Discuss the value of having quality costs reported by segment.

OBJECTIVE 4

Problem 16-33 TREND ANALYSIS, QUALITY COSTS

In 2009, Milton Trang, president of Carbondale Electronics, received a report indicating that quality costs were 31 percent of sales. Faced with increasing pressures from imported goods, Milton resolved to take measures to improve the overall quality of the company's products. After hiring a consultant in 2010, the company began an aggressive program of total quality control. At the end of 2013, Milton requested an analysis of the progress the company had made in reducing and controlling quality costs. The Accounting Department assembled the following data:

	Sales	Prevention	Appraisal	Internal Failure	External Failure
2009	$500,000	$ 5,000	$10,000	$80,000	$60,000
2010	600,000	25,000	15,000	60,000	50,000
2011	700,000	35,000	30,000	35,000	25,000
2012	600,000	40,000	15,000	25,000	20,000
2013	500,000	50,000	5,000	12,000	8,000

Required:

1. Compute the quality costs as a percentage of sales by category and in total for each year.
2. Prepare a multiple-year trend graph for quality costs, both by total costs and by category. Using the graph, assess the progress made in reducing and controlling quality costs. Does the graph provide evidence that quality has improved? Explain.

3. Using the 2009 quality cost relationships (assume all costs are variable), calculate the quality costs that would have prevailed in 2012. By how much did profits increase in 2012 because of the quality improvement program? Repeat for 2013.

Problem 16-34 CASE ON QUALITY COST PERFORMANCE REPORTS

OBJECTIVE 4

SERVICE

Iona Company, a large printing company, is in its fourth year of a five-year, quality improvement program. The program began in 2009 with an internal study that revealed the quality costs being incurred. In that year, a five-year plan was developed to lower quality costs to 10 percent of sales by the end of 2013. Sales and quality costs for each year are as follows:

	Sales Revenues	Quality Costs
2009	$10,000,000	$2,000,000
2010	10,000,000	1,800,000
2011	11,000,000	1,815,000
2012	12,000,000	1,680,000
2013*	12,000,000	1,320,000

*Budgeted figures.

Quality costs by category are expressed as a percentage of sales as follows:

	Prevention	Appraisal	Internal Failure	External Failure
2009	1.0%	3.0%	7.0%	9.0%
2010	2.0	4.0	6.0	6.0
2011	2.5	4.0	5.0	5.0
2012	3.0	3.5	4.5	3.0
2013	3.5	3.5	2.0	2.0

The detail of the 2013 budget for quality costs is also provided.

Prevention costs:	
Quality planning	$ 150,000
Quality training	20,000
Quality improvement (special project)	80,000
Quality reporting	10,000
Appraisal costs:	
Proofreading	500,000
Other inspection	50,000
Failure costs:	
Correction of typos	150,000
Rework (because of customer complaints)	75,000
Plate revisions	55,000
Press downtime	100,000
Waste (because of poor work)	130,000
Total quality costs	$1,320,000

All prevention costs are fixed; all other quality costs are variable.

During 2013, the company had $12 million in sales. Actual quality costs for 2012 and 2013 are as follows:

	2013	2012
Quality planning	$150,000	$140,000
Quality training	20,000	20,000
Quality improvement	100,000	120,000
Quality reporting	12,000	12,000
Proofreading	520,000	580,000
Other inspection	60,000	80,000
Correction of typos	165,000	200,000
Rework	76,000	131,000

	2013	2012
Plate revisions	58,000	83,000
Press downtime	102,000	123,000
Waste	136,000	191,000

Required:

1. Prepare an interim quality cost performance report for 2013 that compares actual quality costs with budgeted quality costs. Comment on the firm's ability to achieve its quality goals for the year.
2. Prepare a one-period quality performance report for 2013 that compares the actual quality costs of 2012 with the actual costs of 2013. How much did profits change because of improved quality?
3. Prepare a graph that shows the trend in total quality costs as a percentage of sales since the inception of the quality improvement program.
4. Prepare a graph that shows the trend for all four quality cost categories for 2009 through 2013. How does this graph help management know that the reduction in total quality costs is attributable to quality improvements?
5. Assume that the company is preparing a second five-year plan to reduce quality costs to 2.5 percent of sales. Prepare a long-range quality cost performance report assuming sales of $15 million at the end of five years. Assume that the final planned relative distribution of quality costs is as follows: proofreading, 50 percent; other inspection, 13 percent; quality training, 30 percent; and quality reporting, 7 percent.

OBJECTIVE 5

SERVICE

Problem 16-35 ENVIRONMENTAL RESPONSIBILITY ACCOUNTING, COST TRENDS

At the beginning of 2010, Lessard Company, an international telecommunications company, embarked on an environmental improvement program. The company set a goal to have all its facilities ISO 14001-registered by 2013. (There are 30 facilities worldwide.) To communicate the environmental progress made, management decided to issue, on a voluntary basis, an annual environmental progress report. Internally, the Accounting Department issued monthly progress reports and developed a number of measures that could be reported even more frequently to assess progress. Lessard also asked an international accounting firm to prepare an auditors' report that would comment on the reasonableness and fairness of Lessard's approach to assessing and measuring environmental performance.

At the end of 2013, the controller had gathered data that would be used in preparing the environmental progress report. A sample of the data collected is as follows:

Year	Number of ISO 14001 Registrations	Energy Consumption (BTUs)[a]	Greenhouse Gases[b]
2010	3	3,000	40,000
2011	9	2,950	39,000
2012	15	2,900	38,000
2013	24	2,850	36,000

[a] In billions (measures electricity, natural gas, and heating oil usage).
[b] In tonnes.

As part of its environmental cost reporting system, Lessard tracks its total environmental costs. Consider the following cost and sales data:

Year	Total Environmental Costs	Sales Revenue
2010	$30,000,000	$250,000,000
2011	25,000,000	250,000,000
2012	22,000,000	275,000,000
2013	19,250,000	275,000,000

Required:

1. Using the data, prepare a bar graph for each of the three environmental variables provided (registrations, energy, and greenhouse gases). Comment on the progress made on these three dimensions.
2. Prepare a bar graph for environmental costs expressed as a percentage of sales. Assuming that environmental performance has improved, explain why environmental costs have decreased.
3. Normalize energy consumption by expressing it as a percentage of sales. Now, prepare a bar graph for energy. Comment on the progress made in reducing energy consumption. How does this compare with the conclusion that would be reached using a non-normalized measure of progress? Which is the best approach? Explain.

Problem 16-36 COST CLASSIFICATION, ECOEFFICIENCY, STRATEGIC ENVIRONMENTAL OBJECTIVES

OBJECTIVE 5 6

SERVICE

The following items are listed in an environmental financial statement (issued as part of an environmental progress report):

Environmental benefits (savings, income, and cost avoidance):

- Ozone-depleting substances cost reductions
- Hazardous waste disposal cost reductions
- Hazardous waste material cost reductions
- Nonhazardous waste disposal cost reductions
- Nonhazardous waste material cost reductions
- Recycling income
- Energy conservation cost savings
- Packaging cost reductions

Environmental costs:

- Corporate-level administrative costs
- Audit fees
- Environmental engineering
- Facility professionals and programs
- Packaging professionals and programs for packaging reductions
- Pollution controls: Operations and maintenance
- Pollution controls: Depreciation
- Legal fees for cleanup claims, notices of violations
- Settlements of government claims
- Waste disposal
- Environmental taxes for packaging
- Remediation/Cleanup: On-site
- Remediation/Cleanup: Off-site

Required:

1. Classify each item in the statement as prevention, detection, internal failure, or external failure. In classifying the items listed in the environmental benefits category, first classify the underlying cost item (e.g., the cost of hazardous waste disposal). Next, think of how you would classify the cost of the activities that led to the cost reduction. That is, how would you classify the macro activity: *reducing hazardous waste cost disposal*?
2. Assuming ecoefficiency, what relationship over time would you expect to observe between the environmental benefits category and the environmental costs category?

Problem 16-37 ENVIRONMENTAL FINANCIAL REPORTING, ECOEFFICIENCY, IMPROVING ENVIRONMENTAL PERFORMANCE

OBJECTIVE 5 6

SERVICE

Refer to **Problem 16-36**. In the environmental benefits section of the report, three types of benefits are listed: income, savings, and cost avoidance. Now, consider the following data for selected items for a four-year period:

Year	Engineering Design Costs	Cost of Ozone-Depleting Substances
2010	$ 180,000	$3,240,000
2011	1,440,000	2,160,000
2012	720,000	1,440,000
2013	90,000	360,000

The engineering design costs were incurred to redesign the production processes and products. Redesign of the product allowed the substitution of a material that produced less ozone-depleting substances. Modifications in the design of the processes also accomplished the same objective. Because of the improvements, the company was able to reduce the demand for pollution control equipment (with its attendant depreciation and operating costs) and avoid fines and litigation costs. All of the savings generated in a given year represent costs avoided for future years. The engineering costs are investments in design projects. Once the results of the project are realized, design costs can be reduced to lower levels. However, since some ongoing design activity is required for maintaining the system and improving it as needed, the environmental engineering cost will not be reduced lower than the $90,000 reported in 2013.

Required:

1. Prepare a partial environmental financial statement, divided into benefit and cost sections for 2011, 2012, and 2013.
2. Evaluate and explain the outcomes. Does this result support or challenge ecoefficiency? Explain.

OBJECTIVE 5

Problem 16-38 ENVIRONMENTAL FINANCIAL REPORT

The following environmental cost reports for 2011, 2012, and 2013 (year end December 31) are for the Communications Products Division of Kartel, a telecommunications company. In 2011, Kartel committed itself to a continuous environmental improvement program, which was implemented throughout the company.

Environmental Activity	2011	2012	2013
Disposing hazardous waste	$200,000	$150,000	$ 50,000
Measuring contaminant releases	10,000	100,000	70,000
Releasing air contaminants	500,000	400,000	250,000
Producing scrap (nonhazardous)	175,000	150,000	125,000
Operating pollution equipment	260,000	200,000	130,000
Designing processes and products	50,000	300,000	100,000
Using energy	180,000	162,000	144,000
Training employees (environmental)	10,000	20,000	40,000
Remediation (cleanup)	400,000	300,000	190,000
Inspecting processes	0	100,000	80,000

At the beginning of 2013, Kartel began a new program of recycling nonhazardous scrap. The effort produced recycling income totalling $25,000. The marketing vice president and the environmental manager estimated that sales revenue had increased by $200,000 per year since 2011 because of an improved public image relative to environmental performance. The company's Finance Department also estimated that Kartel saved $80,000 in 2013 because of reduced finance and insurance costs, all attributable to improved environmental performance. All reductions in environmental costs from 2011 to 2013 are attributable to improvement efforts. Furthermore, any reductions represent ongoing savings.

Required:

1. Prepare an environmental financial statement for 2013 (for the Communications Products Division). In the cost section, classify environmental costs by category (prevention, detection, etc.).
2. Evaluate the changes in environmental performance.

CMA Problem

CMA Problem 16-1 ASSIGNMENT OF ENVIRONMENTAL COSTS*

OBJECTIVE 6

Refer to **Problem 16-38**. In 2011, Jim Caro, president of Kartel, requested that environmental costs be assigned to the two major products produced by the company. He felt that knowledge of the environmental product costs would help guide the design decisions that would be necessary to improve environmental performance. The products represent two different models of a cellular phone (Model XA2 and Model KZ3). The models use different processes and materials. To assign the costs, the following data were gathered for 2011:

Activity	Model XA2	Model KZ3
Disposing hazardous waste (tonnes)	20	180
Measuring contaminant releases (transactions)	1,000	4,000
Releasing air contaminants (tonnes)	25	225
Producing scrap (kilograms of scrap)	25,000	25,000
Operating pollution equipment (hours)	120,000	400,000
Designing processes and products (hours)	1,500	500
Using energy (BTUs)	600,000	1,200,000
Training employees (hours)	50	50
Remediation (labour hours)	5,000	15,000

During 2011, Kartel's division produced 200,000 units of Model XA2 and 300,000 units of Model KZ3.

Required:

1. Using the activity data, calculate the environmental cost per unit for each model. How will this information be useful?
2. Upon examining the cost data produced in Requirement 1, an environmental engineer made the following suggestions: (1) substitute a new plastic for a material that appeared to be the source of much of the hazardous waste (the new material actually cost less than the contaminating material it would replace) and (2) redesign the processes to reduce the amount of air contaminants produced.

   As a result of the first suggestion, by 2013, the amount of hazardous waste produced had diminished to 50 tonnes, 10 tonnes for Model XA2 and 40 tonnes for Model KZ3. The second suggestion reduced the contaminants released by 50 percent by 2013 (15 tonnes for Model XA2 and 110 tonnes for Model KZ3). The need for pollution equipment also diminished, and the hours required for operating this equipment for Model XA2 and Model KZ3 were reduced to 60,000 and 200,000, respectively. Calculate the unit cost reductions for the two models associated with the actions and outcomes described (assume the same production as in 2011). Do you think the efforts to reduce the environmental cost per unit were economically justified? Explain. *(CMA adapted)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

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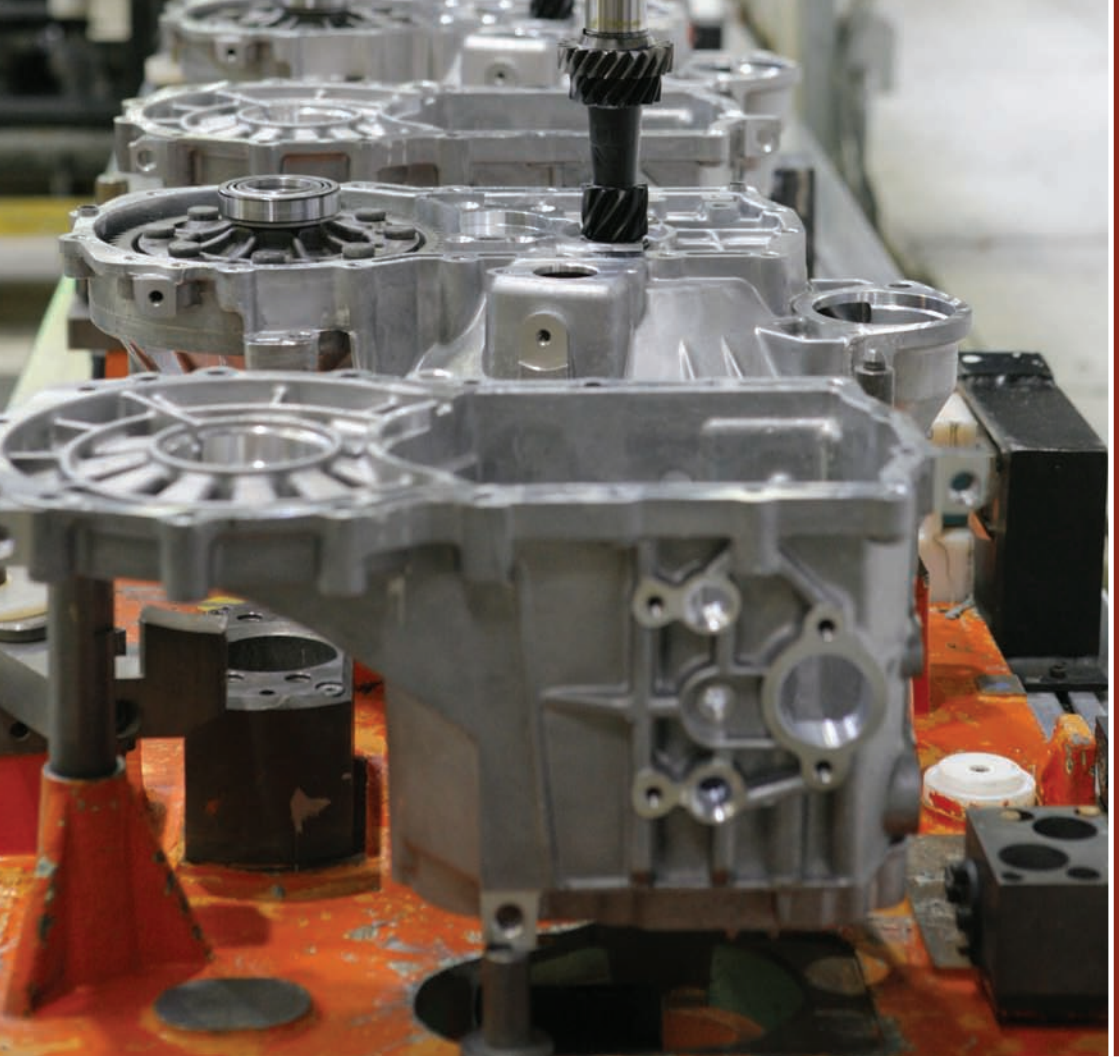


After studying this chapter, you should be able to:

1. Describe the basic features of lean manufacturing.
2. Describe lean accounting.
3. Discuss and define productive efficiency and partial productivity measurement.
4. Explain what total productivity measurement is, and describe its advantages.

CHAPTER

17 Lean Accounting and Productivity Measurement

Consider a hypothetical company, Maple Autoparts Inc., that produces four major product lines: shock absorbers, aluminum alloy and steel wheels, brake systems, and aluminum radiators. Maple is contemplating expansion into new international markets and is facing such competitors as **DENSO** (Japanese), **Bosch** (German), and **Delphi** (American). To achieve success in this endeavour, Maple needs to be more efficient by streamlining operating processes, eliminating waste, and improving quality and delivery performance. Clearly, an organization must be as good as or better than its competitors at taking materials, labour, machines, power, and other inputs and turning out high-quality goods and services. A company can create a competitive advantage by using fewer inputs to produce a given output or by producing more output for a given set of inputs. Management needs to assess the potential and actual effectiveness of decisions that are geared to improve efficiency. Management also needs to monitor and control efficiency changes. Measures of productive efficiency satisfy these performance and control objectives.

Lean manufacturing is concerned with eliminating waste in manufacturing processes. Promised benefits include such outcomes as reduced lead times, improved quality, improved on-time deliveries, less inventory, less space, less human effort, lower costs, and

increased profitability. *Lean accounting* is a simplified approach to costing that supports lean manufacturing with both financial and nonfinancial measures. One key area that supports efficiency improvement is *productivity measurement*, which is concerned with the relationship between outputs and inputs. As waste decreases through lean manufacturing practices, productive efficiency should increase.

Lean Manufacturing

OBJECTIVE 1
Describe the basic features of lean manufacturing.

Maple Autoparts is typical of many companies that operate in an environment where change is rapid. Products and processes are constantly being redesigned and improved, and stiff national and international competitors are always present. The competitive environment demands that firms offer customized products and services to diverse customer segments. This, in turn, means that firms must find cost-efficient ways of producing high-variety, low-volume products and pay more attention to linkages between the firm, its suppliers and customers. Furthermore, for many industries, product life cycles are shrinking, creating a greater need for innovation. Thus, organizations operating in a dynamic, rapidly changing environment are finding that adaptation and change are essential to survival. To find ways to improve performance, firms operating in this kind of environment are forced to re-evaluate how they do things. Improving performance translates into constantly searching for ways to eliminate waste (both time and money) and to undertake only those actions that bring value to the customer. This philosophical approach to manufacturing is often referred to as *lean manufacturing*. **Lean manufacturing** is thus an approach designed to eliminate waste and maximize customer value. It is characterized by delivering the right product, in the right quantity, with the right quality (zero-defect), at the exact time the customer needs it and at the lowest possible cost.

Lean manufacturing systems allow managers to eliminate waste, reduce costs, and become more efficient. Firms that implement lean manufacturing are pursuing a cost reduction strategy by redefining the activities performed within an organization. Cost reduction is directly related to cost leadership. Lean manufacturing adds value by reducing waste. Successful implementation of lean manufacturing has brought about significant improvements, such as better quality, increased productivity, reduced lead times, major reductions in inventories, reduced setup times, lower manufacturing costs, and increased production rates.

In substance, lean manufacturing is the same as the ***Toyota*** *Production System* developed by Shigeo Shingo, Taaichi Ohno, and Eiji Toyoda. *World-class manufacturing* and *just-in-time (JIT) manufacturing and purchasing* are terms that encompass many of the same ideas. Lean manufacturing is also similar in concept to **Ford**'s lean enterprise system. However, the contributions of Shingo, Ohno, and Toyoda overcame some of the major shortcomings and flaws of the Ford system. Specifically, the Ford system did not properly value employees and also was not structured to deal with product variety. High-variety, low-volume products were not compatible with the Ford production system. Employee empowerment, team structures, cellular manufacturing, reduced setup times, and small batches all came into being in the Toyota Production System and are integral parts of a lean manufacturing system.

Becoming lean requires lean thinking. Lean manufacturing is distinguished by the following five principles of lean thinking:[1]

- Precisely specify value by each particular product.
- Identify the "value stream" for each.
- Make value flow without interruption.
- Let the customer pull value from the producer.
- Pursue perfection.

Value by Product

Value is determined by the customer—at the very least, it is an item or feature for which the customer is willing to pay. Customer value is the difference between realization and sacrifice. Realization is what a customer receives. Sacrifice is what a customer

[1] James Womack and Daniel Jones, *Lean Thinking* (New York: Free Press, 2003).

gives up, including what they are willing to pay for the basic and special product features, quality, brand name, and reputation. Value thus relates to a specific product and to specific features of the product. Adding features and functions that are not wanted by the customers is a waste of time and resources. Furthermore, attempting to market features and products that customers don't want is a waste of time and resources. Assessing value is externally oriented and not internally generated. Only value-added features should be produced; non-value-added activities should be eliminated.

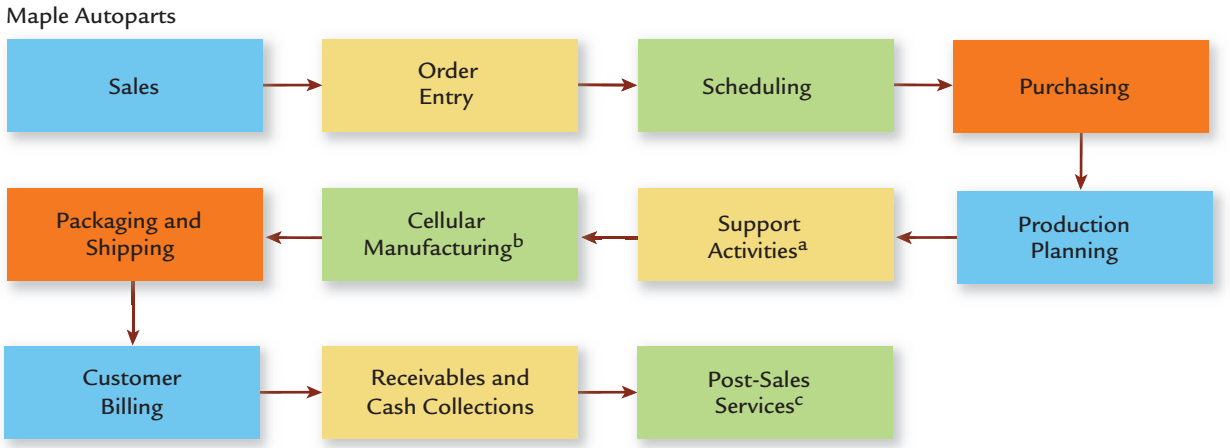
Value Stream

The **value stream** is made up of all activities, both value-added and non-value-added, required to bring a product group or service from its starting point (e.g., customer order or concept for a new product) to a finished product in the hands of the customer. There are several types of value streams, the most common being the *order fulfillment value stream*. The order fulfillment value stream focuses on providing current products to current customers.[2] A second type of value stream is the *new product value stream*, which focuses on developing new products for new or existing customers. A value stream reflects all that is done—both good and bad—to bring the product to a customer. Thus, analyzing the value stream allows management to identify waste. Activities within the value stream are value-added or non-value-added. Non-value-added activities are the source of waste. They are of two types: (1) activities avoidable in the short run and (2) activities unavoidable in the short run due to current technology or production methods. The first type is most quickly eliminated, while the second type requires more time and effort. Exhibit 17-1 visually portrays an order fulfillment value stream for one of Maple Autoparts' family of aluminum wheels. This particular value stream only has one manufacturing cell; other value streams may have several cells.

A value stream may be created for every product; however, it is more common to group products that use common processes into the same value stream. One way to identify the value streams is to use a simple two-dimensional matrix, where the activities/processes are listed on one dimension and the products on a second dimension. Exhibit 17-2 provides a simple matrix for the four-wheel models: aluminum Model A, aluminum Model B, steel Model C, and steel Model D. In this case,

Exhibit 17-1

Order Fulfillment Value Stream



[a]Moving materials, quality management, engineering, setting up equipment, maintenance, etc.
[b]Cutting, drilling and insertion, assembly, and finishing.
[c]Customer complaints, field repairs, warranty services, etc.

[2]For a more complete description of the different types of value streams, see Brian Maskell and Bruce Baggaley, *Practical Lean Accounting* (New York: Productivity Press, 2004), and Francis A. Kennedy and Jim Huntzinger, "Lean Accounting: Measuring and Managing the Value Stream," *Cost Management* (September/October 2005): 31–38. These two sources also recommend the matrix approach for identifying value streams illustrated in Exhibit 17-2.

Exhibit 17-2

Matrix Approach to Identifying Value Streams

	Production Activities: Order Fulfillment Value Stream							
Wheel Model	Order Entry	Production Planning	Purchasing	Aluminum Cell[a]	Steel Cell[b]	Stress Testing[c]	Packaging and Shipping	Invoicing
A	x	x	x	x			x	x
B	x	x	x	x			x	x
C	x	x	x		x	x	x	x
D	x	x	x		x	x	x	x

[a] Casting, machining, painting, and finishing.
[b] Stamping, welding, and cladding (attaching stainless steel or painted plastic components to approximate the look of chromed aluminum).
[c] To ensure that the steel wheels have the same fatigue strength as aluminum, they go through a stress test.

Models A and B would be placed in one value stream.
Models C and D would define a second value stream.

two value streams are indicated, where each is made up of two product models (notice that the steel models have two major processes different from the aluminum models, thus the need for two value streams).

Once value streams are identified, then the next step is to assign people and resources to the value streams. As a rule of thumb, each value stream should have between 25 and 150 people.[3] As much as possible, the people, the machines, the manufacturing processes, and the support activities need to be dedicated to the value streams. This allows a sense of ownership and provides a means of direct accountability. It also simplifies and facilitates product costing. In a sense, the value stream is its own independent company, and the value-stream team is responsible for its improvement, growth, and profitability.

Value Flow

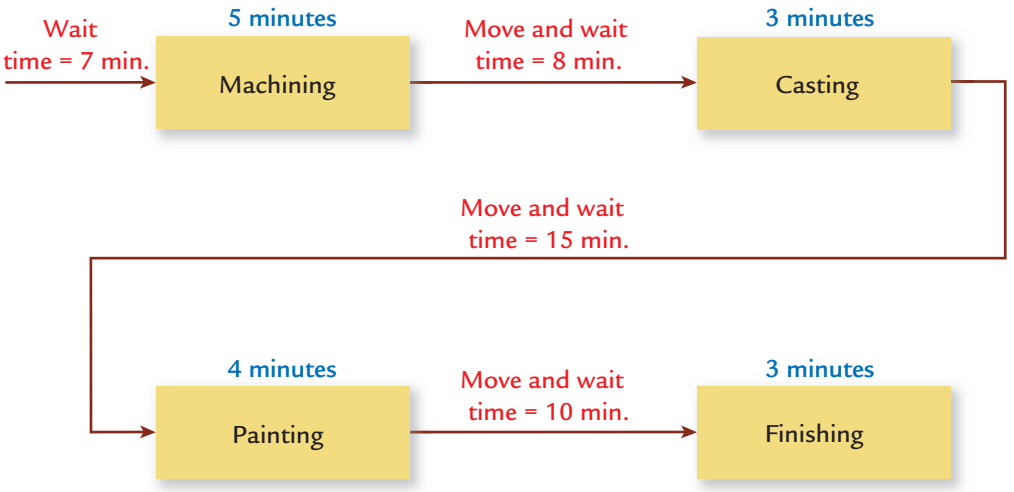
Value flow is made up of all move and wait time necessary to move resources and product batches before and after the production process, to product completion. In a traditional manufacturing setup, production is organized by function into departments and products are produced in large batches, moving from department to department. This approach requires significant move time and wait time as each batch *moves* from one department to another and *waits* for its turn if there is a batch in-process in front of it. Often, lengthy changeovers are needed to prepare the equipment to produce the next batch of goods that may have some very different characteristics. Traditional batch production is not equipped to deal with product variety; furthermore, move and wait time are sources of waste. Batches must wait for a preceding batch and a subsequent setup *before* beginning a process. Once a batch starts a process, units are processed sequentially; as units are finished, they must wait for other units in the batch to be finished before the entire batch moves to the next process. For example, if a department can process one unit every five minutes, then the first unit of a batch of 10 will be completed after five minutes but must then wait an additional 45 minutes for the remaining units to be completed before moving to the next process. Thus, there is pre-process waiting and post-process waiting. Exhibit 17-3 illustrates Maple's current department layout for production of Model A aluminum wheels. The exhibit illustrates the presence of both wait and move times.

Reduced Setup/Changeover Times With large batches, setups are infrequent, and the fixed cost of a setup is spread out over many units. Typical results produce complexity in scheduling and large work-in-process and finished goods inventories. Lean manufacturing reduces wait and move times dramatically and allows the production of small batches (low volume) of differing products (high variety). The key factors in achieving these outcomes are lower setup times and cellular manufacturing. Reducing

[3] Ibid.

Exhibit 17-3

Maple's Current Departmental Layout: Model A Aluminum Wheel Production



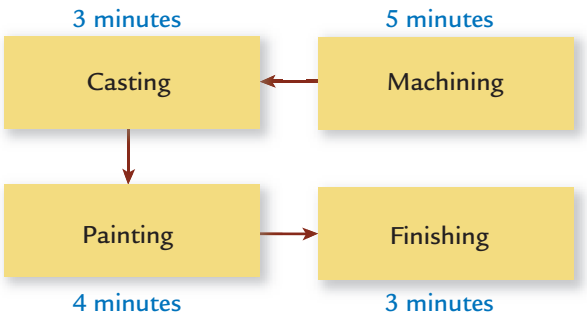
Colour Code:
Blue = Value-added process time
Red = Non-value-added move and pre-process wait time

the time to configure equipment to produce a different type of product enables *smaller batches in greater variety* to be produced. It also decreases the time it takes to produce a unit of output, thus increasing the ability to respond to customer demand. Customers do not value changeover and therefore it represents waste. While reducing setup times is important, even more critical is the use of cellular or continuous flow manufacturing.

Cellular Manufacturing Lean manufacturing uses a series of cells to produce families of similar products. A lean manufacturing system replaces the traditional plant layout with a pattern of manufacturing cells. Cell structure is chosen over departmental structure because it reduces lead time, decreases product cost, improves quality, and increases on-time delivery. **Manufacturing cells** contain all the operations in close proximity that are needed to produce a family of products. The machines used are typically grouped in a semicircle. The reason for locating processes close to one another is to minimize move time and to keep a continuous flow between operations while maintaining zero inventory between any two operations. The cell is usually dedicated to producing products that require similar operations. Exhibit 17-4 shows a proposed cellular manufacturing structure for Model A aluminum wheels. Notice that by grouping processes closely together and dedicating the cell to a family of products, the move and wait times are essentially eliminated. Cornerstone 17-1 illustrates the value of cellular manufacturing relative to the traditional departmental approach.

Exhibit 17-4

Maple's Proposed Manufacturing Cell (Model A)



Blue = Value-added process time

The HOW and WHY of Cellular Manufacturing

CORNERSTONE 17-1

Information:
See Exhibits 17-3 and 17-4.

Why:
Cellular manufacturing groups process closely together, and this act effectively eliminates wait and move times. For a given batch of units, total production time is reduced with subsequent decreases in lead time and cost and improved on-time delivery.

Required:
1. Calculate the total time it takes to produce a batch of 10 units using Maple's traditional departmental structure.
2. Using cellular manufacturing, how much time is saved producing the same batch of 10 units? Assuming the cell operates continuously, what is the production rate? Which process controls this production rate?
3. ***What if*** the processing time of machining is reduced from five to four minutes? What is the production rate now, and how long will it take to produce a batch of 10 units?

Solution:
1. Total lead time for a batch of 10 units:

Processing time	
Machining	50 minutes
Casting	30 minutes
Painting	40 minutes
Finishing	30 minutes
Total processing	150 minutes
Move and wait times	40 minutes
Total batch time	190 minutes

2.

Processing time (10 units):	Elapsed time
First unit	15 minutes
Second unit	20 minutes (processing begins five minutes after the first)
Tenth unit	60 minutes (total processing time)

Time saved over traditional manufacturing: 190 minutes − 60 minutes = 130 minutes

If the cell is processing continuously, then a unit is produced every five minutes after the start-up unit. Thus, the production rate is 12 units per hour (60/5). The *bottleneck* process (the one with the longest per-unit processing time) controls the production rate.

3. Four minutes is now the longest per-unit processing time, and so the production rate is 60/4 = 15 units per hour. Producing 10 units will take 40 minutes [(10/15) × 60].

Pull Value

Pull value refers to a firm's ability to use inventories and produce products in the quantities needed, when needed, driven by a demand pull system. Many firms produce for inventory and then try to sell the excess goods they have produced. Efforts are made to create demand for the excess goods—goods that customers probably do not even want. Lean manufacturing uses a *demand-pull* system. The objective of lean manufacturing is to eliminate waste by producing a product only when it is needed and only in the quantities demanded by customers. Demand pulls products through the manufacturing process. Each operation produces only what is necessary to satisfy the demand of the succeeding operation. No production takes place until a signal from a succeeding process indicates a need to produce. Parts and materials arrive just in time to be used in production. Low setup times and cellular manufacturing are the major enabling factors for producing on demand. The Kanban system described in Chapter 18 [online at www.hansen1ce.nelson.com] is one way to ensure that materials and products flow according to demand.

Customer demand extends back through the value chain and affects how a manufacturer deals with suppliers. Materials inventories also represent waste. Thus, managing supplier linkages is also vital to lean manufacturing. **JIT purchasing** requires suppliers to deliver parts and materials just in time to be used in production. Supply of parts must be linked to production, which is linked to demand. One effect of successful management of customer and supplier linkages is to reduce all inventories to much lower levels.

Traditionally, inventories of raw materials and parts are carried so that a firm can take advantage of quantity discounts and hedge against future price increases of the items purchased. The objective is to lower the cost of inventory. JIT purchasing achieves the same objective without carrying inventories. The JIT solution is to exploit supplier linkages by negotiating long-term contracts with a few chosen suppliers located as close to the production facility as possible and by establishing more extensive supplier involvement. Suppliers are not selected on the basis of price alone. Performance—the quality of the component and the ability to deliver as needed—and commitment to JIT purchasing are vital considerations. Every effort is made to establish a partners-in-profits relationship with suppliers. Suppliers need to be convinced that their well-being is intimately tied to the well-being of the buyer.

To help reduce the uncertainty in demand for the supplier and establish the mutual confidence and trust needed in such a relationship, lean manufacturers emphasize long-term contracts that stipulate prices and acceptable quality levels. Long-term contracts also reduce dramatically the number of orders placed, which helps drive down the ordering costs. Another effect of long-term contracting is a reduction in the cost of parts and materials—usually in the range of 5 percent to 20 percent less than what was paid in a traditional setting. The need to develop close supplier relationships often drives the supplier base down dramatically. Suppliers also benefit, as the long-term contract ensures a reasonably stable demand for their products. A smaller supplier base typically means increased sales for the selected suppliers. Thus, both buyers and suppliers benefit, a common outcome when customer and supplier linkages are recognized and managed well. By reducing the number of suppliers and working closely with those that remain, the quality of the incoming materials can be improved significantly—a crucial outcome for the success of lean manufacturing. As the quality of incoming materials increases, some quality-related costs can be avoided or reduced. For example, the need to inspect incoming materials may disappear, and rework requirements decline.

Pursue Perfection

Zero setup times, zero defects, zero inventories, zero waste, producing on demand, increasing a cell's production rates, minimizing cost, and maximizing customer value represent ideal outcomes that a lean manufacturer seeks. As the process of becoming lean begins to unfold and improvements are realized, the possibility of achieving perfection becomes more believable. The relentless and continuous pursuit of these

ideals is fundamental to lean manufacturing. As the flow increases and processes begin to improve, more hidden waste tends to be exposed. The objective is to produce the highest-quality, lowest-cost products in the least amount of time. To achieve this objective, a lean manufacturer must identify and eliminate the various forms of waste.

Sources of Waste **Waste** consumes resources without adding value. Waste is anything customers do not value. Elimination of waste requires that its various forms be identified. The major sources of waste are listed below.

- Defective products
- Overproduction of goods not needed
- Inventories of goods awaiting further processing or consumption
- Unnecessary processing
- Unnecessary movement of people
- Unnecessary transport of goods
- Waiting
- The design of goods and services that do not meet the needs of the customer

Employee Empowerment Employee involvement is vital for identifying and eliminating all forms of waste. A major procedural difference between traditional and lean environments is the degree of participation allowed workers in the management of the organization. In a lean environment, increasing the degree of participation increases productivity and overall cost efficiency. Managers seek workers' input and use their suggestions to improve production processes. The management structure must change in response to greater employee involvement. Because workers assume greater responsibilities, fewer managers are needed, and the organizational structure becomes flatter. Flatter structures speed up and increase the quality of information exchange. The style of management needed in a lean firm also changes. Managers in a lean environment act as facilitators more than as supervisors. Their role is to develop people and their skills so that they can make value-adding contributions.

Total Quality Control Lean manufacturing necessarily carries with it a much stronger emphasis on managing quality. A defective part brings production to a grinding halt. Poor quality simply cannot be tolerated in a manufacturing environment that operates without inventories. Simply put, lean manufacturing cannot be implemented without a commitment to total quality control (*TQC*). *TQC* is essentially a never-ending quest for perfect quality: the striving for a defect-free product design and manufacturing process. Quality cost management is discussed extensively in Chapter 16.

Inventories Overproduction of goods is controlled by letting customers pull goods through the system. Inventories are lowered by cellular manufacturing, low setup times, JIT purchasing, and a demand-pull system. Inventory management is of such importance that its treatment is covered in a separate chapter, Chapter 18.

Activity-Based Management Process value analysis is the methodology for identifying and eliminating non-value-added activities. Non-value-added activities are unnecessary activities, including waiting, and thus much of the waste in a lean system is attacked using process value analysis. Process value analysis searches for the root causes of the wasteful activities and then, over time, eliminates these activities. See Chapter 14 for a detailed discussion of process value analysis.

Lean Accounting

OBJECTIVE 2
Describe lean accounting.

The numerous changes in structural and procedural activities that we have described for a lean firm also change traditional cost management practices. The traditional cost management system may not work well in the lean environment. In fact, the traditional costing and operational control approaches may actually work against lean

manufacturing. Standard costing variances and departmental budgetary variances will likely encourage overproduction and work against the demand-pull system needed in lean manufacturing. For example, emphasis on labour efficiency by comparing actual hours used with hours allowed for production encourages production to keep labour occupied and productive. Similarly, emphasis on departmental efficiency (e.g., machine utilization rates) will cause non-bottleneck departments to overproduce and build work-in-process inventory. Furthermore, we already know from our study of activity-based costing (ABC) that in a multiple-product plant, the use of a plant-wide overhead rate can produce distorted product costs relative to focused manufacturing assignments or activity-based assignments. Distorted product costs can signal failure for lean manufacturing even when significant improvements may be occurring. To avoid obstacles and false signals, changes in both product-costing and operational control approaches are needed when moving to a value-stream-based lean manufacturing system.[4]

Value Streams and Traceability of Overhead Costs

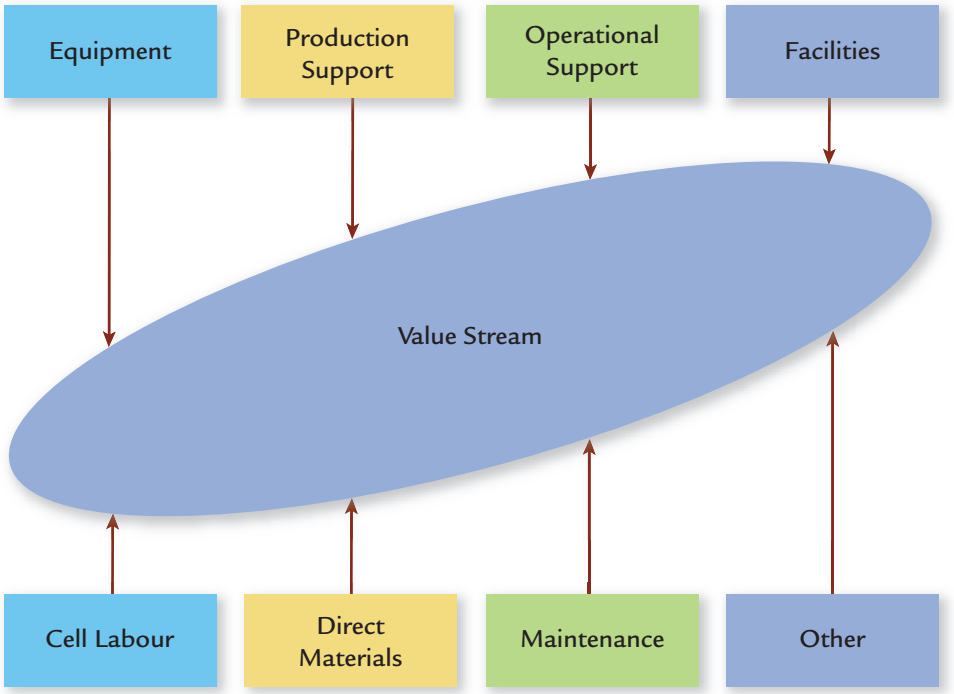
Costing systems use three methods to assign costs to individual products: direct tracing, driver tracing, and allocation. Of the three methods, the most accurate is direct tracing; thus, it is preferred over the other two methods. Assume initially that a value stream is created for each product within a plant. In a lean environment, many overhead costs assigned to products using either driver tracing or allocation are now directly traceable to products. Equipment formerly located in other departments, for example, is now reassigned to value streams, and, under the single-product value-stream structure, is dedicated to the production of a single product. In this case, depreciation is now a directly traceable product cost. Multiskilled workers and decentralized services add to the effect. Workers are assigned to the value stream and are trained to set up the equipment in the cells within the stream, maintain them, and operate them. These support functions were previously handled by a different set of labourers for all product lines. Additionally, people with specialized skills (e.g., industrial engineers and production schedulers) are assigned directly to value streams. The labour cost of these employees is now directly assigned to each value stream. Typically, implementing the value-stream structure does not require an increase in the number of people needed. Lean manufacturing eliminates wasteful activities, reducing the demand for people. For example, when production planning is reduced significantly because of an efficiently functioning demand-pull system, some of those working in production planning can be cross-trained to perform value-added activities within the value stream such as purchasing and quality control.

Exhibit 17-5 is a visual summary of value-stream cost assignments. Most costs are assigned directly to the value stream; however, some costs such as facility costs are assigned to each value stream using cost drivers. Facility costs are assigned using a cost per square metre (total cost/total square metres). If a value stream uses less square metres, it receives less cost. Thus, the purpose of this assignment is to motivate value-stream managers to find ways to occupy less space. As space is made available, it can be used for new product lines or to accommodate increased sales. For example, suppose that the facility costs are $200,000 per year for a plant occupying 20,000 square metres. The cost per square metre is $10. If a value stream occupies 5,000 square metres, it is assigned a cost of $50,000. Should the value stream figure out how to do the same tasks with 4,000 square metres, the cost would be reduced to $40,000. Any unabsorbed facility cost would be deducted from revenue as a separate item.

[4] Much of the material on lean accounting is based on two sources: Frances A. Kennedy and Jim Huntzinger, ''Lean Accounting: Measuring and Managing the Value Stream,'' *Cost Management* (September/October 2005): 31–38, and Brian Maskell and Bruce Baggaley, *Practical Lean Accounting* (New York: Productivity Press, 2004).

Exhibit 17-5

Value-Stream Costs



Limitations and Problems Initially, it may not be possible to assign all the people needed exclusively to a value stream. There may be some individuals working in more than one value stream. The cost of these shared workers can be assigned to individual value streams in proportion to the time spent in each stream. It is also true that even in the most ideal of circumstances, there will be some individuals who will remain outside any particular value stream (the plant manager, for example). However, with multiple value streams, the unassigned costs are likely to be a very small percentage of the total costs. Finally, in reality, having a value stream for every product is not practical. The usual practice is to organize value streams around a family of products.

Value-Stream Costing

Product Costing: Single-Product (Focused) Value Stream Because of multitask assignments, cross-training, and redeployment of other support personnel, most support costs are exclusive to a focused value stream and are thus assigned to a product using direct tracing. One consequence of increasing directly traceable costs is to increase the accuracy of product costing. Directly traceable costs are exclusively associated with the product and can safely be said to belong to it. Product cost is calculated by taking the costs of the period and dividing by the output. Focused value streams provide simple and accurate product costing.

Product Costing: Multiple-Product Value Stream Value streams are formed around products with common processes (see Exhibit 17-2). Manufacturing cells within a value stream are thus structured to make a family of products or parts that require the same manufacturing sequence. The costs are assigned in the same

way as for focused value streams. However, with multiple products, product costs for value streams are calculated using an actual average cost.

Value-stream product cost = Total value-stream cost of period/Units shipped in period

Using units shipped in the unit cost calculation instead of units produced motivates managers to reduce inventories. If more units are shipped than produced, then the weekly average unit cost will decrease and inventories will reduce. If more is produced than shipped, then the unit cost will increase (because the production costs of the units produced and not shipped are added to the numerator), creating a disincentive to produce for inventory. Typically, average costs are calculated weekly and are based on actual costs. The actual costs for Maple Autoparts' value stream for steel wheels are shown in Exhibit 17-6 for the week beginning April 6. Using this information, Cornerstone 17-2 illustrates product costing for single-product and multiple-product value streams.

From Cornerstone 17-2, we see that all products in the value stream receive the same unit cost. However, as Cornerstone 17-2 also shows, if materials cost are quite different between products, then the average unit cost calculation can exclude materials. In this case, the average unit conversion cost is calculated and then added to the unit materials cost, producing different total unit costs. The average product cost is useful provided the products are similar and consume resources in approximately the same proportions or if the product mix is relatively stable. If products are quite similar, the average product cost will approximate the individual product costs. If the mix is stable, then the trend in the average product cost over time is a reasonable measure of changes in economic efficiency. If, however, the products are heterogeneous or reflect a great deal of variety through custom designing, then the average product cost is not a good measure for tracking changes in value-stream efficiency; nor is there much indication of what the cost of individual products is. In this case, other product cost calculation approaches are needed—approaches that provide a much better level of accuracy.

An approach called *features and characteristics costing* is recommended (albeit reluctantly) by those advocating the simple average costing approach. This approach recognizes that some product components take more effort (time) to make than others and thus cost more. (Differences in features and characteristics cause cost differences.) An adjustment is made to the average product cost that reflects this complexity difference. One observation that deserves mention is that value streams with heterogeneous products find themselves in the same cost-distortion dilemma as plants

Exhibit 17-6

Steel Wheel Value-Stream Costs: Models C and D

Maple Autoparts
This Week, April 6

	Materials	Salaries/Wages	Machining	Other	Total Cost
Order processing		$ 12,000			$ 12,000
Production planning		24,000			24,000
Purchasing		18,000			18,000
Stamping	$250,000	25,000	$24,000	$12,000	311,000
Welding	100,000	28,000	28,000	8,000	164,000
Cladding	50,000				50,000
Testing		7,000			7,000
Packaging and shipping		6,000			6,000
Invoicing		8,000			8,000
Totals	$400,000	$128,000	$52,000	$20,000	$600,000

The HOW and WHY of Value-Stream Product Costing

CORNERSTONE 17-2

Information:

See Exhibit 17-6. During the week of April 6, Maple Autoparts produced and shipped 1,000 units of Model C and 4,000 units of Model D, for a total of 5,000 units.

Why:

The unit cost of product(s) in a value stream is the *actual* value-stream costs divided by the *number of units shipped* for a given time period (usually a week). If materials costs are significantly different for multiple products, the unit cost is the average conversion cost plus the unit materials cost.

Required:

1. Assume that the value-stream costs and total units shipped apply only to one model (a single-product value stream). Calculate the unit cost, and comment on its accuracy.
2. Calculate the unit cost for Models C and D, and comment on its accuracy. Explain the rationale for using units shipped instead of units produced in the calculation.
3. ***What if*** Model C is responsible for 50 percent of the materials cost? Show how the unit cost would be adjusted for this condition.

Solution:

1. Unit cost = \$600,000/5,000 = \$120 per unit. The cost is very accurate as the value stream is dedicated to one product and its costs all belong to that product.

2. Unit cost = \$600,000/5,000 = \$120. Each unit of Models C and D receives the same cost of \$120 per unit. The accuracy depends on the homogeneity of the products within the value stream. Using units shipped for the unit calculation motivates managers to reduce inventories.

3. First, the unit materials cost is calculated separately:

$$\text{Model C: } \$200,000^{*}/1,000 = \$200$$
$$\text{Model D: } \$200,000/4,000 = \$50$$

$^{*}50\% \times \$400,000$

Next, the average unit conversion cost is calculated: \$200,000/5,000 = \$40.

Finally, the unit cost is computed (sum of materials and average conversion cost):

$$\text{Model C: } \$200 + \$40 = \$240$$
$$\text{Model D: } \$50 + \$40 = \$90$$

with multiple products and plant-wide overhead rates. ABC solves the distortion problem using causal tracing. ABC could, of course, be used within a value stream. The argument is that ABC is too complex and too data intensive for a lean setting. Yet there is no compelling evidence that features and characteristics costing provides simplicity with accuracy. Further research is needed to create a simpler yet more accurate product cost for a lean accounting environment.

Value-Stream Reporting

Costs are collected and reported by value stream. Consider a plant of Maple Autoparts that produces only four products. Within this plant are two value streams: (1) aluminum

Exhibit 17-7

Maple Autoparts Profit and Loss Statement

Week Ending April 13

	Aluminum Stream	Steel Stream	Sustaining Costs	Plant Totals
Revenues	$ 700,000	$1,500,000		$2,200,000
Material costs	(280,000)	(410,000)		(690,000)
Conversion costs	(70,000)	(190,000)		(260,000)
Value-stream profit	$ 350,000	$ 900,000		1,250,000
Value-stream ROS*	50%	60%		
Employee costs			$(40,000)	(40,000)
Other expenses			(30,000)	(30,000)
Change in inventory:				
Current less prior period				(500,000)
Plant gross profit				$ 680,000
Plant ROS				31%

*ROS = Return on sales = Profit/Sales.

wheels (Models A and B) and (2) steel wheels (Models C and D). Exhibit 17-7 shows a profit and loss statement for the plant, for the week ending April 13. (The plant had significantly increased its sales of steel wheels to auto manufacturers that were replacing low-end aluminum wheels with steel units on new models.) Costs outside the value stream (sustaining costs) are reported in a separate column. The revenues and costs reported are the actual revenues and costs for the week. To avoid distorting the current week's performance, inventory reductions are reported separately from the value-stream contributions. Adding the inventory changes also allows the income to be stated correctly for external reporting.

Decision Making

Using the average product cost for a value stream means that the individual product costs are not known. In reality, a fully specified and accurate product cost is not needed for many decisions. Waste can be eliminated at the activity and process levels without knowing product costs. We do not need detailed variances by product to signal sources of waste and potential for improvement. In fact, as already noted, standard costing variances may actually impede improvement decisions. For other decisions, the effect of the decision on the profitability of value stream may be the only information needed for certain decisions. For example, special order and make-or-buy decisions can be made at the value-stream level.

Consider a make-or-buy decision. Suppose that Maple Autoparts is currently purchasing a component used in making its wheel products and is considering making the component. The decision can be made by comparing the profitability of the value stream under the buy scenario with the profitability under the make scenario. A typical analysis would be as follows for Maple's ABS value stream:

	Buy	Make
Revenue	$1,500,000	$1,500,000
Material costs	(410,000)	(380,000)
Conversion costs	(190,000)	(200,000)
Value-stream profit	$ 900,000	$ 920,000

The profitability of the value stream increases under the make alternative, and so the decision would be to make the component rather than buy it.

While analysis of the effect on value-stream profitability has its merits, it also has its perils. Many of the decisions are short term in nature and do not reflect the long-term consequences. For example, acceptance of a special order below the full cost of a product (unknown with average cost) may increase value-stream profitability because of existing unused value-stream capacity, but continued acceptance of such orders may not earn the return necessary to replace capacity that is eventually exhausted through use. Thus, other very important decisions may need individual product cost information, and a lean accounting system must provide this information.[5]

Performance Measurement

Abandoning a standard cost system also removes a major operational control system, and it must be replaced. The lean control system uses a Box Scorecard that compares operational, capacity, and financial metrics with prior week performances and with a future desired state. Trends over time and the expectation of achieving some desired state in the near future are the means used to motivate constant performance improvement. Thus, the lean control approach uses a mixture of financial and nonfinancial measures for the value stream. The future desired state reflects targets for the various measures. Operational, nonfinancial measures are also used at the cell level. A typical value-stream Box Scorecard is shown in Exhibit 17-8 (metrics and format can vary). Only a brief introduction to the Box Scorecard is made because the Balanced Scorecard is a more thorough and integrated approach that encompasses the concepts of a Box Scorecard.

For the operational measures, units sold per person is a partial labour productivity measure and is therefore a measure of labour *efficiency*. Productivity measures are

Exhibit 17-8

ABS Value-Stream Box Scorecard

For 4/6/2013

	Last Week	This Week (4/6/13)	Planned Future State (6/30/13)
Operational			
Units sold per person	250	270	280
On-time delivery	90%	92%	97%
Dock-to-dock days	18.5	18	16
First-time through	56%	58%	65%
Average product cost	$128	$120	$115
Accounts receivable days	31	30	28
Capacity			
Productive	21%	20%	25%
Nonproductive	45%	46%	30%
Available	34%	34%	45%
Financial			
Weekly sales	$1,800,000	$1,500,000	$2,000,000
Weekly material cost	$800,000	$600,000	$600,000
Weekly conversion cost	$400,000	$300,000	$400,000
Weekly value-stream profit	$600,000	$600,000	$1,000,000
ROS	33%	40%	50%

[5] Ibid.

discussed more completely later in this chapter. Dock-to-dock is the *time* it takes for a product to be manufactured from the moment the materials arrive at the receiving dock until the finished product is shipped from the shipping dock. Dock-to-dock is a cycle time measure, a concept that was studied in Chapter 15. First-time through is a measure of *quality* and is simply the percentage of product that made it through production without being defective and thus needing to be rejected or reworked. Capacity is labelled as *productive* (value-added), *nonproductive* (non-value-added—used but wasteful), and *available* (unused) capacity. The scorecard measures are expected to improve over time and to be helpful in managing and bringing about improvement. For example, from the Box Scorecard in Exhibit 17-8, we see that the nonproductive capacity is targeted to go from 46 percent (current state) to 30 percent (future state), with productive capacity increasing from 20 percent to 25 percent and available capacity increasing from 34 percent to 45 percent. As waste is eliminated, the nonproductive capacity converts into available capacity. The machines, people, and other resources used for wasteful activities are now available for more productive work. For financial performance to improve, some decisions must be made with respect to the increase in available capacity. The most sensible and practical approach is to commit to use the freed-up resources to expand the business. One possibility is to add new product lines. Another possibility is to transfer the resources to other value streams that are in a high-growth state with increasing resource demands. Another is to realize cost reductions by reducing headcount and eliminating resources. This latter approach is the least desirable. It makes it hard to gain the cooperation and involvement of employees with the transformation into a lean workforce if their suggestions and actions are going to lead to the loss of their jobs or the jobs of their friends and coworkers.

OBJECTIVE 3

Discuss and define productive efficiency and partial productivity measurement.

Productivity

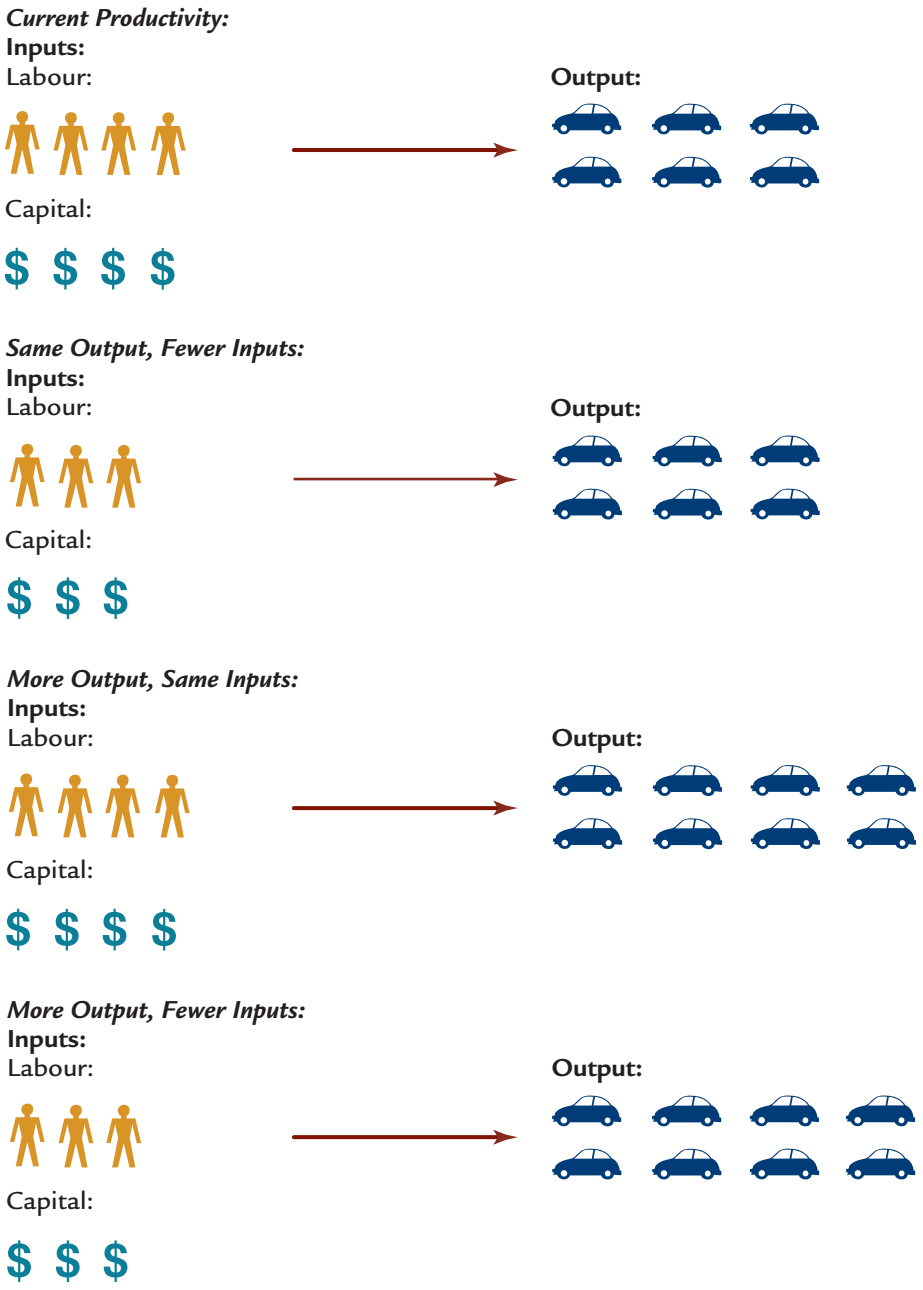
A key objective of lean manufacturing and accounting is that of increasing overall productive efficiency. **Productivity** is concerned with producing output efficiently, and it specifically addresses the relationship of output and the inputs used to produce the output. Usually, different combinations or mixes of inputs can be used to produce a given level of output. **Total productive efficiency** is the point at which two conditions are satisfied: (1) for any mix of inputs that will produce a given output, no more of any one input is used than necessary to produce the output and (2) given the mixes that satisfy the first condition, the least costly mix is chosen. The first condition is driven by technical relationships and, therefore, is referred to as **technical efficiency**. Technical improvements in productivity can be achieved by using fewer inputs to produce the same output, by producing more output using the same inputs, or by producing more output with relatively fewer inputs. The second condition is driven by relative input price relationships and, therefore, is referred to as **allocative efficiency**. Input prices determine the *relative proportions* of each input that should be used. Choosing the right combination of inputs can also produce significant improvements in economic efficiency. Exhibits 17-9 and 17-10 illustrate technical and allocative efficiency improvements. The output in the exhibits is vehicles, and the inputs are labour (number of workers) and capital (dollars invested in automated equipment).

Partial Productivity Measurement Defined

Productivity measurement is simply a quantitative assessment of productivity changes. The objective is to assess whether productive efficiency has increased or decreased. Productivity measurement can be actual or prospective. Actual productivity measurement allows managers to assess, monitor, and control changes. Prospective measurement is forward looking, and it serves as input for strategic decision making. Specifically, prospective measurement allows managers to compare relative benefits of

Exhibit 17-9

Improving Technical Efficiency



different input combinations, choosing the inputs and input mix that provide the greatest benefit. Productivity measures can be developed for each input separately or for all inputs jointly. Measuring productivity for one input at a time is called **partial productivity measurement**.

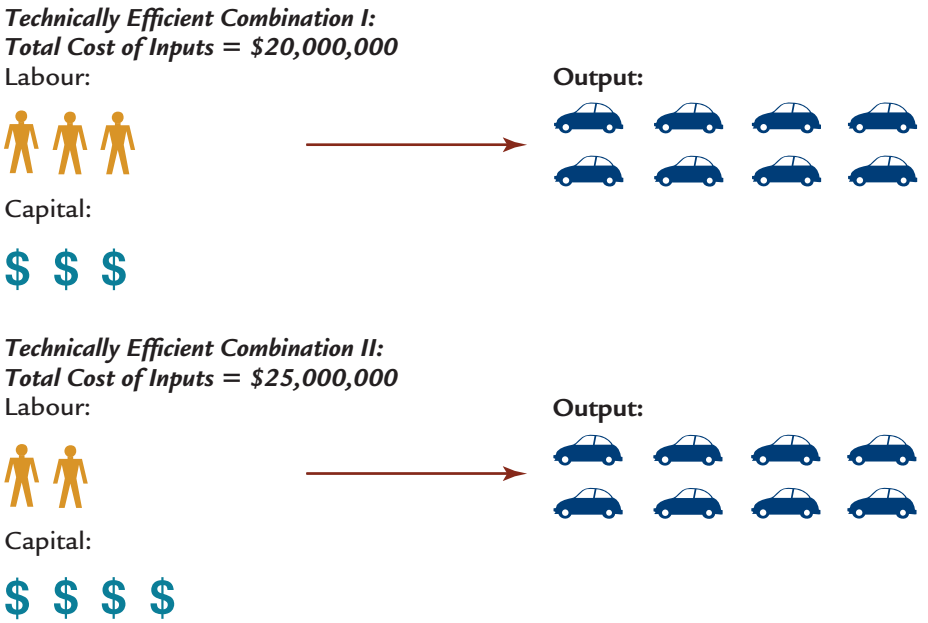
Productivity of a single input is typically measured by calculating the ratio of the output to the input as follows:

$$\text{Productivity ratio} = \text{Output/Input}$$

Because the productivity of only one input is being measured, the measure is called a *partial productivity measure*. If both output and input are measured in physical quantities, then we have an **operational productivity measure**. If output

Exhibit 17-10

Improving Allocative Efficiency



or input is expressed in dollars, then we have a **financial productivity measure**. Cornerstone 17-3 illustrates partial productivity measurement.

Assume, for example, that in 2012, Tydek Company produced 240,000 frames for snowmobiles and used 60,000 hours of labour. The labour productivity ratio is four frames per hour (240,000/60,000). This is an operational measure, since the units are expressed in physical terms. If the selling price of each frame is $30 and the cost of labour is $15 per hour, then output and input can be expressed in dollars. The labour productivity ratio, expressed in financial terms, is $8 of revenue per dollar of labour cost ($7,200,000/$900,000).

Measuring Changes in Productive Efficiency The labour productivity ratio of four frames per hour measures the 2012 productivity experience of Tydek. By itself, the ratio conveys little information about productive efficiency or whether the company has improving or declining productivity. It is possible, however, to make a statement about increasing or decreasing productivity efficiency by measuring *changes* in productivity. To do so, the actual current productivity measure is compared with the productivity measure of a prior period. This prior period is referred to as the **base period** and serves to set the benchmark or standard for measuring changes in productive efficiency. The prior period can be any period desired. It could, for example, be the preceding year, the preceding week, or even the period during which the last batch of products was produced. For strategic evaluations, the base period is usually chosen as an earlier year. For operational control, the base period tends to be close to the current period—such as the preceding batch of products or the preceding week.

To illustrate, assume that 2012 is the base period and that the labour productivity standard, therefore, is four frames per hour. Further assume that late in 2012, Tydek decided to try a new procedure for producing and assembling the frames with the expectation that the new procedure would use less labour. In 2013, 250,000 frames were produced, using 50,000 hours of labour. The labour productivity ratio for 2013 is five frames per hour (250,000/50,000). The *change* in productivity is a one-unit-per-hour *increase* in productivity (from four units per hour in 2012 to five

units per hour in 2013). The change is a significant improvement in labour productivity and provides evidence supporting the efficacy of the new process.

Advantages of Partial Measures Partial measures allow managers to focus on the use of a particular input. Operating partial measures have the advantage of being easily interpreted by everyone within the organization. Consequently, partial operational measures are easy to use for assessing productivity performance of operating personnel. Labourers, for instance, can relate to units produced per hour or units produced per kilogram of material. Thus, partial operational measures provide feedback that operating personnel can relate to and understand—measures that deal with the specific inputs over which they have control. The ability of operating personnel to understand and relate to the measures increases the likelihood that the measures will be accepted. Furthermore, for operational control, the standards for performance are often very short run in nature. For example, standards can be the productivity ratios of prior batches of goods. Using this standard, productivity trends within the year itself can be tracked.

Disadvantages of Partial Measures Partial measures, used in isolation, can be misleading. A decline in the productivity of one input may be necessary to increase the productivity of another. Such a trade-off is desirable if overall costs decline, but the effect would be missed by using either partial measure. For example, changing a process so that direct labourers take less time to assemble a product may increase scrap and waste while leaving total output unchanged. Labour productivity has increased, but productive use of materials has declined. If the increase in the cost of waste and scrap outweighs the savings of the decreased labour, then overall productivity has declined.

Two important conclusions can be drawn from this example. First, the possible existence of trade-offs mandates a total measure of productivity for assessing the merits of productivity decisions. Only by looking at the total productivity effect of all inputs can managers accurately draw any conclusions about overall productivity performance. Second, because of the possibility of trade-offs, a total measure of productivity must assess the aggregate financial consequences and, therefore, should be a financial measure.

Total Productivity Measurement

OBJECTIVE 4
Explain what total productivity measurement is, and describe its advantages.

Measuring productivity for all inputs at once is called **total productivity measurement**. In practice, it may not be necessary to measure the effect of all inputs. Many firms measure the productivity of only those factors that are thought to be relevant indicators of organizational performance and success. Thus, in practical terms, total productivity measurement can be defined as focusing on a limited number of inputs, which, in total, indicates organizational success. In either case, total productivity measurement requires the development of a multifactor measurement approach. A common multifactor approach suggested in the productivity literature (but rarely found in practice) is the use of aggregate productivity indexes. Aggregate indexes are complex and difficult to interpret and have not been generally accepted. Two approaches that have gained some acceptance are *profile measurement* and *profit-linked productivity measurement*.

Profile Productivity Measurement Producing a product involves numerous critical inputs such as labour, materials, capital, and energy. **Profile measurement** provides a series or vector of separate and distinct partial operational measures. Profiles (vectors or series of measures) can be compared over time to provide information about productivity changes. When the partial productivity ratios move in the same direction when compared with the base period ratios, some definitive statements about productivity changes can be made. However, if the ratios move in opposite directions, a trade-off exists and the comparison of profiles provides a mixed signal

about productivity changes. Furthermore, while a profile analysis reveals if a trade-off exists, it does not reveal whether the trade-off is good or bad. If the economic effect of the productivity changes is positive, then the trade-off is good; otherwise, it must be viewed as bad. Cornerstone 17-3 illustrates profile productivity measurement and reveals its limitations.

As Cornerstone 17-3 shows, profile analysis can provide managers with useful insights about changes in productivity. However, comparing productivity profiles will not always reveal the nature of the overall change in productive efficiency. Often, it may be necessary to *value* input productivity trade-offs to assess the nature of *overall* productivity change.

Profit-Linked Productivity Measurement Assessing the effects of productivity changes on current profits is one way to value productivity changes. Profits change from the base period to the current period. Some of that profit change is attributable to productivity changes. Measuring the amount of profit change attributable to productivity change is defined as **profit-linked productivity measurement**.

Assessing the effect of productivity changes on current-period profits will help managers understand the economic importance of productivity changes. Linking productivity changes to profits is described by the following rule:

> **Profit-Linkage Rule.** *For the current period, calculate the cost of the inputs that would have been used in the absence of any productivity change and compare this cost with the cost of the inputs actually used. The difference in costs is the amount by which profits changed because of productivity changes.*

The formula corresponding to the linkage rule is given below.

$$\text{Profit-linked productivity change} = \sum PQ_i P_i - \sum AQ_i P_i$$

where

PQ_i = The amount of input i that would have been used for the current period in the absence of a productivity change
P_i = Current-period price of input i
AQ_i = Actual amount of input i used in the current period
$\sum$ represents the sum of the items that follow it.

To apply the linkage rule formula, the inputs that would have been used for the current period in the absence of a productivity change must be calculated. To determine PQ_i, divide the current-period output by the input's base-period productivity ratio:

$$PQ_i = \text{Current-period output/Base-period productivity ratio for input } i$$

The profit-linked measure computes the amount of profit change from the base period to the current period attributable to productivity changes. Generally, this will not be equal to the total profit change between the two periods. The difference between the total profit change and the profit-linked productivity change is called the **price-recovery component**. This component is the change in revenue less a change in the cost of inputs, *assuming no productivity changes*. It, therefore, measures the ability of revenue changes to cover changes in the cost of inputs, assuming no productivity change, and is calculated as follows:

$$\text{Price recovery} = \text{Total profit change} - \text{Profit-linked productivity change}$$

Cornerstone 17-4 illustrates the application of the profit-linked rule.

Cornerstone 17-4 reveals that the net effect of the process change implemented by Tydek was favourable, increasing profits by $12,500. Profit-linked productivity effects can be assigned to individual inputs. The increase in labour productivity creates a $187,500 increase in profits; however, the drop in materials productivity caused a $175,000 decrease in profits. Most of the profit decrease came from an increase in materials usage—apparently, waste, scrap, and spoiled units are much greater with the new process. Thus, the profit-linked measure provides partial measurement effects as

The HOW and WHY of Profile Productivity Measurement

CORNERSTONE 17-3

Information:

In 2013, Tydek Company implements a new production and assembly process affecting labour and materials with the following reported data:

	2012	2013
Number of frames produced	240,000	250,000
Labour hours used	60,000	50,000
Materials used (kg)	1,200,000	1,150,000

Why:

Profiles (vectors) of productivity measures can be compared over time to assess productivity changes. If the changes are in the same direction, then a definitive statement about productivity can be made; if a trade-off exists, valuing the individual input productivity changes is needed to assess the nature of the overall productivity change.

Required:

1. Calculate the productivity profile for 2012.
2. Calculate the productivity profile for 2013, and comment on the effect of the new production and assembly process.
3. ***What if*** the materials used in 2013 were 1,300,000 kilograms? What does comparison of the 2012 and 2013 profiles now communicate?

Solution:

1.

Partial Operational Productivity Ratios	2012 Profile*
Labour productivity ratio	4.000
Material productivity ratio	0.200

*Labour: 240,000/60,000; Materials: 240,000/1,200,000

2.

Partial Operational Productivity Ratios	2013 Profile*
Labour productivity ratio	5.000
Material productivity ratio	0.217

*Labour: 250,000/50,000; Materials: 250,000/1,150,000

Comparing the 2012 profile (4, 0.200) with the 2013 profile (5, 0.217), productivity increased for each input; thus, the new process has improved overall productivity.

3.

Partial Operational Productivity Ratios	2012 Profile[a]	2013 Profile[b]
Labour productivity ratio	4.000	5.000
Material productivity ratio	0.200	0.192

[a]Labour: 240,000/60,000; Materials: 240,000/1,200,000
[b]Labour: 250,000/50,000; Materials: 250,000/1,300,000

Labour productivity has increased, and materials productivity has decreased. A trade-off between the two inputs exists and must be valued to assess the nature of the overall productivity change.

CORNERSTONE 17-4

The HOW and WHY of Profit-Linked Productivity Measurement

Information:

In 2013, Tydek Company implements a new process affecting labour and materials. The following two years of expanded data are provided:

	2012	2013
Number of frames produced	240,000	250,000
Labour hours used	60,000	50,000
Materials used (kg)	1,200,000	1,300,000
Unit selling price (frames)	$30	$30
Wages per labour hour	$15	$15
Cost per kilogram of material	$3	$3.50

Why:

The productivity effect on current-period profit is the difference in the cost of the inputs that would have been used and the cost of the actual inputs used. Price recovery is the difference in the actual profit change and the profit-linked productivity change.

Required:

1. Calculate the cost of inputs in 2013, assuming no productivity change from 2012 to 2013.
2. Calculate the actual cost of inputs for 2013. What is the net value of the productivity changes? How much profit change is attributable to each input's productivity change?
3. ***What if*** a manager wants to know how much of the total profit change from 2012 to 2013 is attributable to price recovery? Calculate the price-recovery component and comment on its meaning.

Solution:

1. Base-period productivity ratios: 4 (labour) and 0.200 (materials). Thus, we have:

$$PQ \text{ (labour)} = 250{,}000/4 = 62{,}500 \text{ hrs.}$$
$$PQ \text{ (materials)} = 250{,}000/0.200 = 1{,}250{,}000 \text{ kg}$$

Cost of labour ($PQ \times P = 62{,}500 \times \$15$)	$ 937,500
Cost of materials ($PQ \times P = 1{,}250{,}000 \times \$3.50$)	4,375,000
Total PQ cost	$5,312,500

2.

Cost of labour ($AQ \times P = 50{,}000 \times \$15$)	$ 750,000
Cost of materials ($AQ \times P = 1{,}300{,}000 \times \$3.50$)	4,550,000
Total current cost	$5,300,000

CORNERSTONE 17-4 (continued)

Profit-linked productivity measure:

Input	(1) PQ	(2) PQ × P	(3) AQ	(4) AQ × P	(2) – (4) (PQ – AQ) × P
Labour	62,500	$ 937,500	50,000	$ 750,000	$ 187,500
Materials	1,250,000	4,375,000	1,300,000	4,550,000	(175,000)
		$5,312,500		$5,300,000	$ 12,500

Net productivity change = $12,500. Labour productivity change = $187,500. Materials productivity change = $(175,000).

3.

	2012	2013	2013–2012
Revenues	$7,200,000	$7,500,000	$ 300,000
Cost of inputs	4,500,000	5,300,000	(800,000)
Profit	$2,700,000	$2,200,000	$(500,000)

Price recovery = Total profit change – Profit-linked productivity change
= $(500,000) – $12,500
= $(512,500)

The increase in revenues would not have been sufficient to recover the increase in the cost of the inputs. The increase in productivity provided some relief for the price-recovery problem.

well as a total measurement effect. The total profit-linked productivity measure is the sum of the individual partial measures. This property makes the profit-linked measure ideal for assessing trade-offs. A much clearer picture of the effects of the changes in productivity emerges. Unless waste and scrap can be brought under better control, the company ought to return to the old assembly process. Of course, it is possible that the learning effects of the new process are not yet fully captured and that further improvements in labour productivity might be observed. As labour becomes more proficient at the new process, it is possible that the materials usage could also decrease.

Summary of Learning Objectives

1. Describe the basic features of lean manufacturing.

- Lean manufacturing has two principal objectives: eliminating waste and creating value for the customer.
- It is characterized by lean thinking—focusing on customer value, value streams, production flow, demand-pull, and perfection.
- Value streams are made up of all activities, both value-added and non-value-added, required to bring a product group or service from its starting point (e.g., customer order or concept for a new product) to a finished product in the hands of the customer.
- Value-stream analysis allows waste to be identified and eliminated.

2. Describe lean accounting.

- Lean accounting is an approach designed to support and encourage lean manufacturing.
- Average costing, value-stream cost reporting, and the heavy use of nonfinancial measures for operational control are typical lean accounting approaches.
- The average product cost is the total value-stream cost of the period divided by the units shipped in the period.
- Value-stream costing reports the actual revenues and actual costs on a weekly basis (for each value stream).
- The lean control system uses a Box Scorecard that compares operational, capacity, and financial metrics with prior-week performances and with a future desired state.
- Simplicity and compatibility are major characteristics of lean accounting.

3. Discuss and define productive efficiency and partial productivity measurement.

- Productivity deals with how efficiently inputs are used to produce the output.
- Technical efficiency is concerned with producing a given output using no more than necessary of any input.
- Allocative efficiency is concerned with choosing the least costly technically efficient combination of inputs.
- Partial measures of productivity evaluate the efficient use of single inputs.

4. Explain what total productivity measurement is, and describe its advantages.

- Total measures of productivity assess efficiency for all inputs.
- Profile measures are vectors of series of partial measures but provide mixed signals if the productivity changes for inputs are in opposite directions.
- Profit-linked measures value trade-offs in input productivity changes.

CORNERSTONES FOR CHAPTER 17

CORNERSTONE 17-1 The HOW and WHY of cellular manufacturing, page 843

CORNERSTONE 17-2 The HOW and WHY of value-stream product costing, page 849

CORNERSTONE 17-3 The HOW and WHY of profile productivity measurement, page 857

CORNERSTONE 17-4 The HOW and WHY of profit-linked productivity measurement, page 858

Review Problems

I. MCE, Lean Measures, and the Balanced Scorecard

Numark Inc. manufactures a product that experiences the following activities and times (the production processes are listed in sequential order):

	Minutes
Cutting	20
Welding	15
Assembly	7
Polishing	3
Moving (three moves)	12
Waiting	18

Required:

1. Compute the time required to produce one unit of product under the current production layout.
2. Assume that Numark creates a manufacturing cell that eliminates move and wait times. What is the production rate assuming continuous production?
3. If the time for the cutting operation is cut in half, what effect will this have on the production rate?

Solution:

1. Production time for one unit is 75 minutes (20 + 15 + 7 + 3 + 12 + 18).
2. Production rate = 60/20 = 3 units per hour.
3. Production rate = 60/15 = 4 units per hour. The cycle time of the slowest operation is now welding (15 minutes).

II. Productivity

At the end of 2012, Alma Company implemented a new labour process and redesigned its product with the expectation that input usage efficiency would increase. Now, at the end of 2013, the president of the company wants an assessment of the changes in the company's productivity. The data needed for the assessment are as follows:

	2012	2013
Output	10,000	12,000
Output prices	$20	$20
Materials (kg)	8,000	8,400
Materials unit price	$6	$8
Labour (hrs)	5,000	4,800
Labour rate per hour	$10	$10
Power (kwh)	2,000	3,000
Price per kwh	$2	$3

Required:

1. Compute the partial operational measures for each input for both 2012 and 2013. What can be said about productivity improvement?
2. Prepare a partial income statement for each year, and calculate the total change in profits.
3. Calculate the profit-linked productivity measure for 2013. What can be said about the productivity program?
4. Calculate the price-recovery component. What does this tell you?

Solution:

1. Partial measures:

	2012	2013
Materials	10,000/8,000 = 1.25	12,000/8,400 = 1.43
Labour	10,000/5,000 = 2.00	12,000/4,800 = 2.50
Power	10,000/2,000 = 5.00	12,000/3,000 = 4.00

Profile analysis indicates that productive efficiency has increased for materials and labour and decreased for power. The outcome is mixed, and no statement about overall productivity improvement can be made without valuing the trade-off.

2. Income statements:

	2012	2013
Sales	$200,000	$240,000
Cost of inputs	102,000	124,200
Gross profit	$ 98,000	$115,800

Total change in profits: $115,800 − $98,000 = $17,800 increase

3. Profit-linked measurement:

Input	(1) PQ*	(2) PQ × P	(3) AQ	(4) AQ × P	(2) − (4) (PQ × P) − (AQ × P)
Materials	9,600	$ 76,800	8,400	$ 67,200	$ 9,600
Labour	6,000	60,000	4,800	48,000	12,000
Power	2,400	7,200	3,000	9,000	(1,800)
		$144,000		$124,200	$19,800

*Materials: 12,000/1.25; Labour: 12,000/2; Power: 12,000/5

The value of the increases in efficiency for materials and labour more than offsets the increased usage of power. Thus, the productivity improvement program should be labelled as successful.

4. Price recovery:

$$\text{Price-recovery component} = \text{Total profit change} - \text{Profit-linked productivity change}$$
$$\text{Price-recovery component} = \$17,800 - \$19,800$$
$$= \$(2,000)$$

This says that without the productivity improvement, profits would have declined by $2,000. The $40,000 increase in revenues would not have offset the increase in the cost of inputs. From the solution to Requirement 3, the cost of inputs without a productivity increase would have been $144,000 (column 2). The increase in the input cost without a productivity change would have been $144,000 − $102,000 = $42,000. This is $2,000 more than the increase in revenues. Only because of the productivity increase did the firm show an increase in profitability.

Key Terms

Allocative efficiency, 852
Base period, 854
Financial productivity measure, 854
JIT purchasing, 844
Lean manufacturing, 839
Manufacturing cells, 842
Operational productivity measure, 853
Partial productivity measurement, 853
Price-recovery component, 856
Productivity, 852
Productivity measurement, 852
Profile measurement, 855
Profit-Linkage Rule, 856
Profit-linked productivity measurement, 856
Technical efficiency, 852
Total productive efficiency, 852
Total productivity measurement, 855
Value stream, 840
Waste, 845

Discussion Questions

1. What is lean manufacturing?
2. What are the five principles of lean thinking?
3. Identify two types of value streams and explain how they differ.
4. How are value streams identified and created?
5. Explain how lean manufacturing is able to produce small batches (low-volume products) of differing products (high variety).
6. What role does a demand-pull system have on lean manufacturing?
7. Identify eight forms and sources of waste.
8. What is a focused value stream?
9. What is the purpose of assigning facility costs to value streams, using a fixed price?
10. Why are units shipped used to calculate the value-stream product cost?

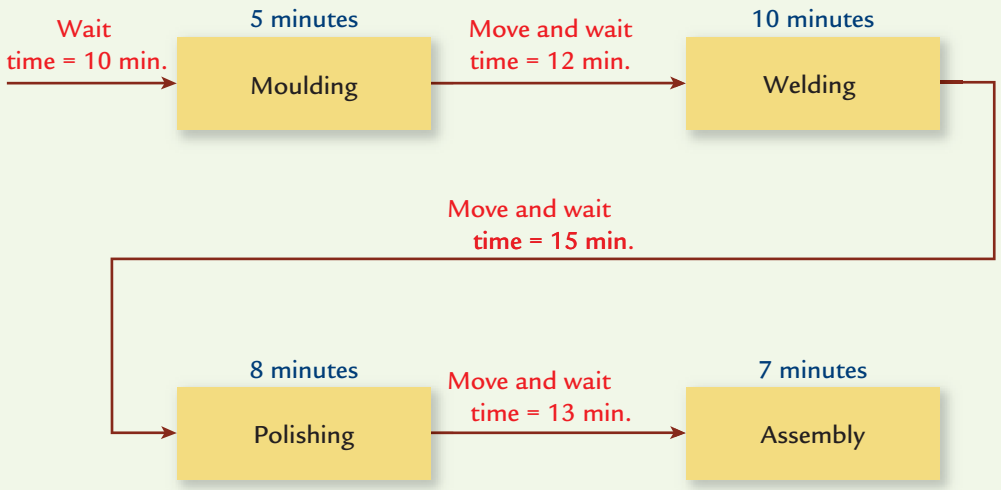
11. When will the average unit cost be useful for value streams?
12. Explain why changes in value-stream profitability may be better information than individual product cost for certain decisions.
13. Define total productive efficiency.
14. Explain the difference between technical and allocative efficiency.
15. What is productivity measurement?
16. Explain the difference between partial and total measures of productivity.
17. What is an operational productivity measure? A financial measure?
18. Discuss the advantages and disadvantages of partial measures of productivity.
19. What is the purpose of a base period?
20. What is profile measurement and analysis? What are the limitations of this approach?
21. What is profit-linked productivity measurement and analysis?
22. Explain why profit-linked productivity measurement is important.
23. What is the price-recovery component?

Cornerstone Exercises

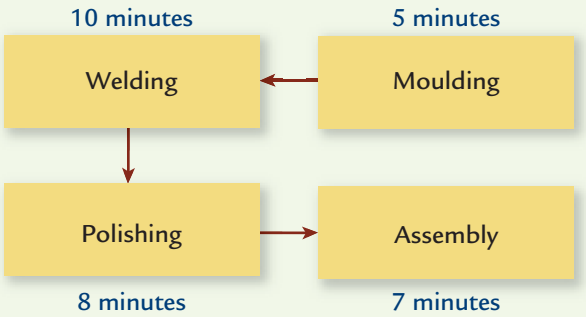
OBJECTIVE 1
CORNERSTONE 17-1

Cornerstone Exercise 17-1 CONTINUOUS FLOW VS. DEPARTMENTAL FLOW MANUFACTURING

Barker Company has the following departmental manufacturing structure for one of its products:



After some study, the production manager of Barker recommended the following revised cellular manufacturing approach:



Required:

1. Calculate the total time it takes to produce a batch of 20 units using Barker's traditional departmental structure.

2. Using cellular manufacturing, how much time is saved producing the same batch of 20 units? Assuming the cell operates continuously, what is the production rate? Which process controls this production rate?
3. ***What if*** the processing times of moulding, welding, and assembly are all reduced to four minutes each? What is the production rate now, and how long will it take to produce a batch of 20 units?

OBJECTIVE 2

CORNERSTONE 17-2

Cornerstone Exercise 17-2 VALUE-STREAM COSTING

During the week of June 12, Leonard Manufacturing produced and shipped 7,500 units of its aluminum wheels: 1,500 units of Model A and 6,000 units of Model B. The following costs were incurred:

	Materials	Salaries/ Wages	Machining	Other	Total Cost
Order processing		$ 36,000			$ 36,000
Production planning		72,000			72,000
Purchasing		54,000			54,000
Stamping	$ 750,000	75,000	$ 72,000	$36,000	933,000
Welding	300,000	84,000	84,000	24,000	492,000
Cladding	150,000				150,000
Testing		21,000			21,000
Packaging and shipping		18,000			18,000
Invoicing		24,000			24,000
Totals	$1,200,000	$384,000	$156,000	$60,000	$1,800,000

Required:

1. Assume initially that the value-stream costs and total units shipped apply only to one model (a single-product value stream). Calculate the unit cost, and comment on its accuracy.
2. Calculate the unit cost for Models A and B, and comment on its accuracy. Explain the rationale for using units shipped instead of units produced in the calculation.
3. ***What if*** Model A is responsible for 40 percent of the materials cost? Show how the unit cost would be adjusted for this condition.

OBJECTIVE 3

CORNERSTONE 17-3

Cornerstone Exercise 17-3 PROFILE PRODUCTIVITY MEASUREMENT

In 2013, Brisbois Company implements a new process affecting labour and materials. The following reported data are provided to evaluate the effect on the company's productivity:

	2012	2013
Number of units produced	180,000	150,000
Labour hours used	36,000	25,000
Materials used (kg)	720,000	500,000

Required:

1. Calculate the productivity profile for 2012.
2. Calculate the productivity profile for 2013, and comment on the effect of the new production and assembly process.
3. ***What if*** the labour hours used in 2013 were 37,500? What does comparison of the 2012 and 2013 profiles now communicate?

OBJECTIVE 4

CORNERSTONE 17-4

Cornerstone Exercise 17-4 PROFIT-LINKED PRODUCTIVITY MEASUREMENT

Refer to **Cornerstone Exercise 17-3**. Brisbois Company provides the following additional information so that total productivity can be valued:

	2012	2013
Number of units produced	180,000	150,000
Labour hours used	36,000	37,500
Materials used (kg)	720,000	500,000
Unit selling price	$20	$22
Wages per labour hour	$12	$14
Cost per kilogram of material	$3.40	$3.50

Required:

1. Calculate the cost of inputs in 2013, assuming no productivity change from 2012 to 2013.
2. Calculate the actual cost of inputs for 2013. What is the net value of the productivity changes? How much profit change is attributable to each input's productivity change?
3. ***What if*** a manager wants to know how much of the total profit change from 2012 to 2013 is attributable to price recovery? Calculate the price-recovery component, and comment on its meaning.

Exercises

Exercise 17-5 VALUE-STREAM IDENTIFICATION

OBJECTIVE 1

Helix Inc. formed the following matrix for its five products:

	Production Activities/Processes							
Product Model	Order Entry	Production Planning	Subassembly 47A Cell	Basic Cell	Assembly Cell	Inspecting	Packaging and Shipping	Warranty
A	x	x		x	x	x	x	x
B	x	x	x		x	x	x	
C	x	x		x			x	x
D	x	x		x	x	x	x	x
E	x	x	x		x	x	x	

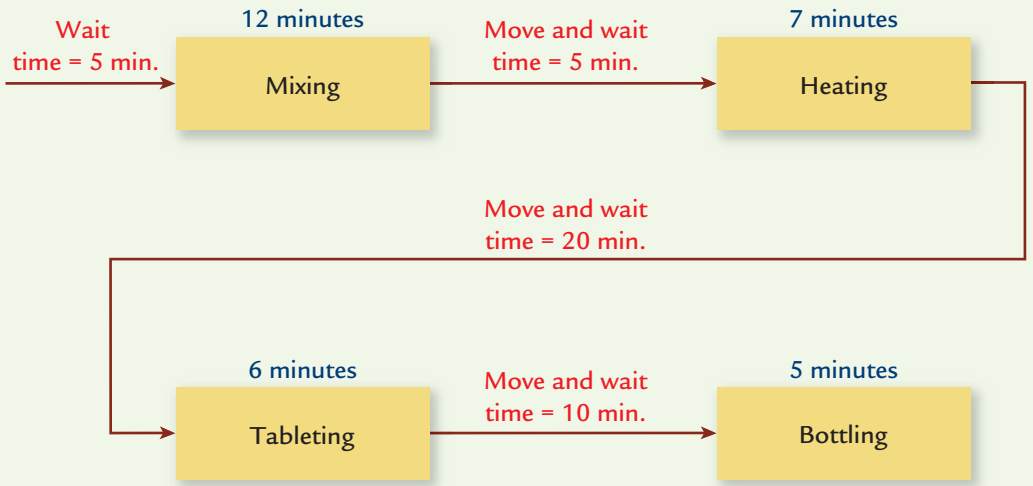
Required:

Using the information in the matrix, identify the value streams.

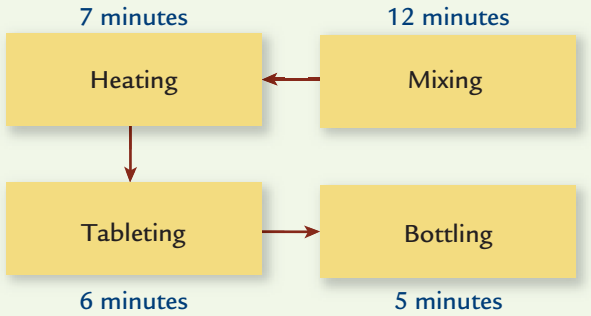
Exercise 17-6 CONTINUOUS FLOW VERSUS DEPARTMENTAL FLOW MANUFACTURING

OBJECTIVE 1

Vitacom Inc. has the following departmental structure for producing a well-known multi-vitamin:



A consultant designed the following cellular manufacturing structure for the same product:



The times shown represent the time required to process one unit of product.

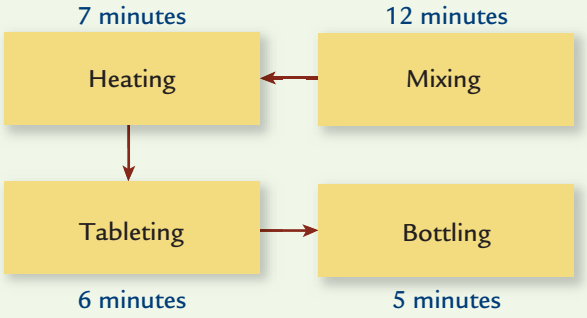
Required:

1. Calculate the time required to produce a batch of 12 bottles using a batch processing departmental structure.
2. Calculate the time to process 12 bottles using cellular manufacturing.
3. How much manufacturing time will the cellular manufacturing structure save for a batch of 12 bottles?

OBJECTIVE 1

Exercise 17-7 BOTTLENECK OPERATION, IMPROVING PRODUCTION FLOW

Vitacom Inc. implemented cellular manufacturing as recommended by a consultant. The production flow improved dramatically. However, the company was still faced with the competitive need to improve its cycle time so that it could produce one bottle every four minutes (15 bottles per hour). The cell structure is shown below; the times above the process represent the time required to process one unit.



Required:

1. How many bottles can the cell produce per hour (on a continuous running basis)?
2. How long does it take to produce one bottle, assuming the cell is producing on a continuous basis?
3. What must happen so that the cell can produce one bottle every four minutes or 15 per hour, assuming the cell produces on a continuous basis?

OBJECTIVE 2

Exercise 17-8 VALUE-STREAM COSTING

Farber Inc. has just created five order fulfillment value streams, two focused and three that produce multiple products. The size of the plant in which the value streams are located is 100,000 square metres. The facility costs total $1,000,000 per year. One of the focused value streams produces a basic MP3 product. The MP3 value stream occupies 20,000 square metres. Not counting facility costs, the MP3 value-stream costs total $1,800,000. There are 25,000 MP3 units produced annually. There were not sufficient quality personnel for each value stream; thus, the MP3 stream had to share a quality engineer who spends 40 percent of his time with the MP3 value stream and the other

60 percent with two other value streams. While 40 percent of the time is not sufficient time for the value streams, the contribution will be workable until other arrangements can be made. His salary is $75,000 per year. Vivian Olsen, an industrial engineer, is one of two employees assigned completely to the value stream from production planning. Vivian has not been with the company as long as the other production engineer. Because of the demand-pull nature of the new value stream, only one production planner is needed.

Required:

1. Explain how the value-stream costs of $1,800,000 were most likely assigned to the MP3 value stream. Explain how facility costs will be treated and why.
2. How many employees are likely to be located within the MP3 value stream?
3. Given that only one production planner is needed, what should the company do with its extra engineer (Vivian Olsen)?
4. Calculate the unit product cost for the MP3 value stream. Comment on the accuracy of this cost and its value for monitoring value-stream performance.

Exercise 17-9 VALUE-STREAM AVERAGE COSTING, ABC COSTS AS BENCHMARKS

OBJECTIVE 2

A value stream has three activities and two products. The units produced and shipped per week are 100 of the deluxe model (Model A) and 300 of the basic model (Model B). The resource consumption patterns are shown as follows:

	Model A	Model B	Costs of Value-Stream Activities
Cell manufacturing	1,200 minutes	3,600 minutes	$38,400
Engineering	30 hours	130 hours	13,600
Testing	50 hours	110 hours	12,000
Total			$64,000

Required:

1. Calculate the ABC product cost for Models A and B.
2. Calculate the value-stream average product cost. Assuming reasonable stability in the consumption patterns of the products and product mix, assess how well the products are grouped based on similarity.

Exercise 17-10 VALUE-STREAM REPORTING WITH INVENTORY DECREASE

OBJECTIVE 2

Shorts Manufacturing Inc. has implemented lean manufacturing in its Quebec City plant as a pilot program. One of its value streams produces a family of small electric tools. The value-stream team managers were quite excited about the results, as some of their efforts to eliminate waste were proving to be effective. During the most recent three weeks, the following data pertaining to the electric tool value stream were collected:

Week 1:

Demand = 90 units @ $40
Beginning inventory = 10 units @ $20 ($5 materials and $15 conversion)
Production = 90 units using $450 of material and $1,350 of conversion cost

Week 2:

Demand = 100 units @ $40
Beginning inventory = 10 units @ $20 ($5 materials and $15 conversion)
Production = 90 units using $450 of material and $1,350 of conversion cost

Week 3:

Demand = 90 units @ $40
Beginning inventory = 0
Production = 100 units using $500 of material and $1,500 of conversion cost

Required:

1. Prepare a traditional income statement for each week.
2. Calculate the average value-stream product cost for each week. What does this cost signal, if anything?
3. Prepare a value-stream income statement for each week. Assume that any increase in inventory is valued at average cost. Comment on the financial performance of the value stream and its relationship to traditional income measurement.

OBJECTIVE 2

Exercise 17-11 BOX SCORECARD

The following Box Scorecard was prepared for a value stream:

	Last Week	This Week (6/30/13)	Planned Future State (12/31/13)
Operational			
Units sold per person	100	108	115
On-time delivery	85%	90%	95%
Dock-to-dock days	12	11	9
First-time through	60%	62%	70%
Average product cost	$75	$74	$70
Capacity			
Productive	25%	26%	27%
Nonproductive	65%	62%	40%
Available	10%	12%	33%
Financial			
Weekly sales	$800,000	$825,000	$1,000,000
Weekly material cost	$320,000	$330,000	$380,000
Weekly conversion cost	$280,000	$280,240	$320,000
Weekly value-stream profit	$200,000	$214,760	$300,000
ROS	25%	26%	30%

Required:

1. How many nonfinancial measures are used to evaluate performance? Why are nonfinancial measures used?
2. Classify the operational measures as time-based, quality-based, or efficiency-based. Discuss the significance of each category for lean manufacturing.
3. What is the role of the Planned Future State column?
4. Discuss the capacity category and explain the meaning of each measure and its significance.
5. Discuss the relationship between the financial measures and the measures in the operational and capacity categories.

OBJECTIVE 3

Exercise 17-12 TECHNICAL AND PRICE EFFICIENCY

Listed below are several possible input combinations for producing 7,500 units of a pocket PC. Two of the input combinations are technically efficient.

	Materials	Labour	Energy
Unit input prices	$100	$ 60	$ 25
Input combinations:			
A	100	192	720
B	110	180	540
C	150	200	600
D	92	190	570

Required:

1. Identify the technically efficient input combinations. Explain your choices.
2. Which of the two technically efficient input combinations should be used? Explain.

Exercise 17-13 PRODUCTIVITY MEASUREMENT, TECHNICAL AND ALLOCATIVE EFFICIENCY, PARTIAL MEASURES

OBJECTIVE 3

Corelli Company produces hand-crafted pottery that uses two inputs: materials and labour. During the past quarter, 24,000 units were produced, requiring 96,000 kilograms of materials and 48,000 hours of labour. An engineering efficiency study commissioned by the local university revealed that Carsen can produce the same 24,000 units of output using either of the following two combinations of inputs:

	Materials	Labour
Combinations:		
F1	72,000	36,000
F2	79,200	33,600

The cost of materials is $8 per kilogram; the cost of labour is $12 per hour.

Required:

1. Compute the output-input ratio for each input of Combination F1. Does this represent a productivity improvement over the current use of inputs? What is the total dollar value of the improvement? Classify this as a technical or an allocative efficiency improvement.
2. Compute the output-input ratio for each input of Combination F2. Does this represent a productivity improvement over the current use of inputs? Now, compare these ratios to those of Combination F1. What has happened?
3. Compute the cost of producing 24,000 units of output using Combination F1. Compare this cost to the cost using Combination F2. Does moving from Combination F1 to Combination F2 represent a productivity improvement? Explain.

Exercise 17-14 INTERPERIOD MEASUREMENT OF PRODUCTIVITY PROFILES

OBJECTIVE 4

Helena Company needs to increase its profits and so has embarked on a program to increase its overall productivity. After one year of operation, Kent Olson, manager of the Halifax plant, reported the following results for the base period and its most recent year of operations:

	2012	2013
Output	307,200	360,000
Power (quantity used)	38,400	18,000
Materials (quantity used)	76,800	81,000

Required:

Compute the productivity profiles for each year. Did productivity improve? Explain.

Exercise 17-15 INTERPERIOD MEASUREMENT OF PRODUCTIVITY, PROFIT-LINKED MEASUREMENT

OBJECTIVE 4

Refer to **Exercise 17-14**. Suppose the following input prices are provided for each year:

	2012	2013
Unit price (power)	$ 2	$ 3
Unit price (materials)	16	15
Unit selling price	6	8

Required:

1. Compute the profit-linked productivity measure. By how much did profits increase due to productivity?
2. Calculate the price-recovery component for 2013. Explain its meaning.

OBJECTIVE 3 4

Exercise 17-16 BASICS OF PRODUCTIVITY MEASUREMENT

Holbrook Company gathered the following data for the past two years:

	Base Year	Current Year
Output	900,000	1,080,000
Output prices	$15	$15
Input quantities:		
Materials (kg)	1,200,000	1,080,000
Labour (hrs)	300,000	540,000
Input prices:		
Materials	$5	$6
Labour	$8	$8

Required:

1. Prepare a productivity profile for each year.
2. Prepare partial income statements for each year. Calculate the total change in income.
3. Calculate the change in profits attributable to productivity changes.
4. Calculate the price-recovery component. Explain its meaning.

Problems

OBJECTIVE 3 4

Problem 17-17 FOCUSED VALUE STREAMS, PRODUCT COSTING

SERVICE

Sixty employees (all CAs) of a local public accounting firm eat lunch at least twice weekly at a very popular pizza restaurant. The pizza restaurant recently began offering discounts for groups of 15 or more. Groups would be seated in a separate room, served individual bowls of salad costing $2 each, pitchers of root beer costing $3 each (each pitcher has a five-glass capacity), and medium, two-topping pizzas for $10 (10 slices each). The food would have to be ordered in advance.

Thirty of the CAs commit to eating three slices of pizza, three glasses of root beer, and one bowl of salad [a consumption pattern of (3,3,1)]. The other 30 are more hearty eaters and commit to seven slices of pizza, two glasses of root beer, and one bowl of salad [a consumption pattern of (7,2,1)]. Each member of the group must pay an assessed amount for the lunch.

Required:

1. Determine the total number of pizzas, pitchers of root beer, and salads that must be ordered for the 60 employees.
2. One of the CAs offered to determine the amount that each should pay. He suggested that the easiest way is to assign the average cost to each person eating in the group. Based on this suggestion, how much would each CA pay for lunch?
3. One CA objected to using average cost, noting that half of the CAs are much lighter eaters than the other half. Based on the large differences in consumption behaviours, he suggested forming two groups: one for the light eaters and one for the heavier eaters. Calculate the lunch cost for each CA for each group. Discuss the analogy to formation of focused value streams in a manufacturing environment. Calculate the cost that would be assigned using ABC. What does this tell you?

OBJECTIVE 3 4

Problem 17-18 MULTIPLE-PRODUCT VALUE STREAMS, PRODUCT COSTING, CREATING AVAILABLE CAPACITY

SERVICE

Refer to **Problem 17-17**.

After some detailed polling among the 60, four types of eaters were identified: two types of light eaters and two types of heavy eaters. The consumption patterns for each group are given (slices of pizza, glasses of root beer, and bowls of salad): Light Eaters (Group A): A1 = (2,2,1) and A2 = (3,3,1); Heavy Eaters (Group B): B1 = (6,3,1) and B2 = (7,2,1). There are an equal number of CAs in each of the four groups.

Required:

1. Calculate the average lunch cost for each CA in each of the two groups, A and B. Compare this to the ABC cost assignments. Discuss the merits of grouping based on similarity. Discuss the analogy to multiple-product value streams.
2. Suppose that members of the heavy-eating group (Group B) decided that they were eating more than necessary for their health and well-being and decided to reduce their total calories. They therefore agreed to reduce consumption of pizza by one slice and consumption of root beer by one glass for each member of the group. Relative to the original order, how much extra capacity exists? If the excess capacity is eliminated by reducing the order, what is the new average cost? Suppose that the decision is to use the extra capacity to invite four guests (two of Type B1 and two of Type B2) to lunch (at the cost of the CAs). If the original order is used as the benchmark cost, what is the extra cost of the guest program? Comment on the conceptual significance of this for manufacturing firms.

Problem 17-19 BOX SCORECARD, SPECIAL ORDER DECISION

OBJECTIVE 2

Jingbao Company, a manufacturer of small tools, implemented lean manufacturing at the end of 2012. The company's goal for the year was to increase the ROS to 40 percent of sales. A value-stream team was established and began to work on lean improvements. During the year, the team was able to achieve significant results on several fronts. The Box Scorecard below reflects the performance measures at the beginning of the year, midyear, and end of year. Although the team members were pleased with their progress, they were disappointed in the financial results. They were still far from the targeted ROS of 40 percent. They were also puzzled as to why the improvements made did not translate into significantly improved financial performance.

	January 1, 2013	June 30, 2013	December 31, 2013
Operational			
Revenue per person	$15,000	$15,000	$15,000
On-time delivery	70%	90%	95%
Dock-to-dock days	15	6	5
First-time through	60%	60%	90%
Average product cost	$60	$60	$59
Capacity			
Productive	40%	40%	40%
Nonproductive	50%	30%	10%
Available	10%	30%	50%
Financial			
Weekly sales	$800,000	$800,000	$800,000
Weekly material cost	$260,000	$260,000	$240,000
Weekly conversion cost	$300,000	$300,000	$300,000
Weekly value-stream profit	$240,000	$240,000	$260,000
ROS	30%	30%	32.5%

Required:

1. From the scorecard, what was the focus of the value-stream team for the first six months? The second six months? What are the implications of these changes?
2. Using information from the scorecard, offer an explanation for why the financial results were not as good as expected.
3. Suppose that on December 31, 2013, a potential customer offered to purchase an order of goods that would increase weekly revenues in January by $100,000 and material cost by $30,000. Using the old standard cost system, the projected conversion cost of the order would be $60,000. Would you recommend that the order be accepted or rejected? Explain.

OBJECTIVE 1 2

Problem 17-20 LEAN VERSUS STANDARD-COSTING-BASED MEASURES

Continuous improvement is the governing principle of a lean accounting system. Following are several performance measures. Some of these measures would be associated with a traditional standard-costing accounting system, and some would be associated with a lean accounting system.

a. Materials price variances
b. Cycle time
c. Comparison of actual product costs with target costs
d. Materials quantity or efficiency variances
e. Comparison of actual product costs over time (trend reports)
f. Comparison of actual overhead costs, item by item, with the corresponding budgeted costs
g. Comparison of product costs with competitors' product costs
h. Percentage of on-time deliveries
i. First-time through
j. Reports of value- and non-value-added costs
k. Labour efficiency variances
l. Days of inventory
m. Downtime
n. Manufacturing cycle efficiency (*MCE*)
o. Unused (available) capacity variance
p. Labour rate variance
q. Using a sister plant's best practices as a performance standard

Required:

1. Classify each measure as lean or traditional (standard costing). If traditional, discuss the measure's limitations for a lean environment. If it is a lean measure, describe how the measure supports the objectives of lean manufacturing.
2. Classify the measures into operational (nonfinancial) and financial categories. Explain why operational measures are better for control at the shop level (production floor) than financial measures. Should any financial measures be used at the operational level?
3. Suggest some additional measures that you would like to see added to the list that would be supportive of lean objectives.

OBJECTIVE 3 4

Problem 17-21 PRODUCTIVITY AND QUALITY, PROSPECTIVE ANALYSIS

Walnut Company is considering the acquisition of a computerized manufacturing system. The new system has a built-in quality function that increases the control over product specifications. An alarm sounds whenever the product falls outside the programmed specifications. An operator can then make some adjustments on the spot to restore the desired product quality. The system is expected to decrease the number of units scrapped because of poor quality. The system is also expected to decrease the amount of labour inputs needed. The production manager is pushing for the acquisition because he believes that productivity will be greatly enhanced—particularly when it comes to labour and material inputs. Output and input data follow. The data for the computerized system are projections.

	Current System	Computerized System
Output (units)	20,000	20,000
Output selling price	$40	$40
Input quantities:		
Materials	80,000	70,000
Labour	40,000	30,000
Capital (dollars)	$40,000	$200,000
Energy	20,000	50,000
Input prices:		
Materials	$4.00	$4.00
Labour	$9.00	$9.00
Capital (percent)	10.00%	10.00%
Energy	$2.00	$2.50

Required:

1. Compute the partial operational ratios for materials and labour under each alternative. Is the production manager right in thinking that materials and labour productivity increase with the automated system?
2. Compute the productivity profiles for each system. Does the computerized system improve productivity?
3. Determine the amount by which profits will change if the computerized system is adopted. Are the trade-offs among the inputs favourable? Comment on the system's ability to improve productivity.

Problem 17-22 PRODUCTIVITY MEASUREMENT, BASICS

OBJECTIVE 4

Fowler Company produces handcrafted leather purses. Virtually all of the manufacturing cost consists of materials and labour. Over the past several years, profits have been declining because the cost of the two major inputs has been increasing. Wilma Fowler, the president of the company, has indicated that the price of the purses cannot be increased; thus, the only way to improve or at least stabilize profits is to increase overall productivity. At the beginning of 2013, Wilma implemented a new cutting and assembly process that promised less materials waste and a faster production time. At the end of 2013, Wilma wants to know how much profits have changed from the prior year because of the new process. In order to provide this information to Wilma, the controller of the company gathered the following data:

	2012	2013
Unit selling price	$16	$16
Purses produced and sold	18,000	24,000
Materials used	36,000	40,000
Labour used	9,000	10,000
Unit price of materials	$4	$4.50
Unit price of labour	$9	$10

Required:

1. Compute the productivity profile for each year. Comment on the effectiveness of the new production process.
2. Compute the increase in profits attributable to increased productivity.
3. Calculate the price-recovery component, and comment on its meaning.

Problem 17-23 PRODUCTIVITY MEASUREMENT, TECHNICAL AND PRICE EFFICIENCY

OBJECTIVE 3 4

In 2012, Farouk Chemicals used the following input combination to produce 55,000 litres of an industrial solvent:

Materials	33,000 kg
Labour	66,000 hrs

In 2013, Farouk again planned to produce 55,000 litres of solvent and was considering two different changes in process, both of which would be able to produce the desired output. The following input combinations are associated with each process change:

	Change I	Change II
Materials	38,500 kg	27,500 kg
Labour	44,000 hrs.	55,000 hrs.

The following combination is optimal for an output of 55,000 units. However, this optimal input combination is unknown to Farouk:

Materials	22,000 kg
Labour	44,000 hrs

The cost of materials is $60 per kilogram, and the cost of labour is $15 per hour. These input prices hold for 2012 and 2013.

Required:

1. Compute the productivity profiles for each of the following:
   a. The actual inputs used in 2012
   b. The inputs for each proposed 2013 process change
   c. The optimal input combination. Will productivity increase in 2013, regardless of which change is used? Which process change would you recommend based on the prospective productivity profiles?
2. Compute the cost of 2012's productive inefficiency relative to the optimal input combination. Repeat for 2013 proposed input changes. Will productivity improve from 2012 to 2013 for each process change? If so, by how much? Explain. Include in your explanation a discussion of changes in technical and allocative efficiency.
3. Since the optimal input combination is not known by Farouk, suggest a way to measure productivity improvement. Use this method to measure the productivity improvement achieved from 2012 to 2013. How does this measure compare with the productivity improvement measure computed using the optimal input combination?

CMA Problem

CMA Problem 17-1 LEAN ACCOUNTING AND PRODUCTIVITY*

Kastoria Inc. produces handcrafted leather purses. Virtually all manufacturing costs consist of materials and labour. Both material and labour costs have been increasing the past few years, and as a result the profits follow suit. Angie Diamantatos, the company's president, is aware that the increased costs cannot be passed on to the consumer in higher prices, as cheaper imports from the Far East sell at very competitive prices. She is instead focusing on productivity measures to improve profitability. To stimulate employees in 2013, she created a bonus pool over and above wages equal to 10 percent of productivity gains. She now wants to assess how the bonus pool has worked to improve productivity. The following data has been gathered:

	2012	2013
Selling price per unit	$32	$32
Unit price of materials	$8	$9
Unit price of labour	$9	$10
Sales in units	100,000	120,000
Kilograms of material used	200,000	200,000
Hours of labour used	50,000	50,000

Required:

1. What are the partial productivity ratios for each year?
2. Comment on the effectiveness of the productivity improvement program.
3. Compute the increase in profits due to improved productivity after the bonus is paid.
4. Calculate the price recovery component ignoring the bonus. What do you think? *(Adapted from CMA Ontario)*

The Collaborative Learning Exercises can be found on the product support site at www.hansen1ce.nelson.com.

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Integrative Exercise 4

Part 4
Chapters 15–17

Zando Pharmaceuticals is an affiliate of the German-based Heisenberg Corporation, which employs 40,000 worldwide. Zando's Vancouver facility houses the Canadian corporate headquarters and Research and Development. It produces 30 products, using 28 different batch processes. The facility has 2,000 employees on-site. In recent years, Zando's profitability has suffered, which can be attributed to increased competition, customer dissatisfaction, and regulatory pressures. Tony Brown, president of Zando, called a meeting to consider ways to improve profitability. He labelled the meeting a strategic planning session and invited the following officers: Kathy Shorts, environmental manager, Troy Lewis, head of R&D, Johnny Mizukawa, vice president of production and quality, Larry Sower, vice president of finance, and Doreen Dineen, marketing vice president.

Tony: You all have received the quarterly financial reports for the past two years. The trends are negative. We are losing market share, profits are decreasing, and our costs seem to be increasing. We need to take actions to increase sales and reduce costs, and we need to do so as quickly as possible. Given our research strengths, it seems to me that our best bet is to grow revenues by introducing new products with proprietary rights. As far as costs are concerned, we need to improve our performance on that dimension as well. Lower per-unit costs for new and existing products are needed. Any suggestions?

Troy: For our products, our ability to control costs resides in development—my area—rather than manufacturing. We probably need to pay more attention to product and process design issues to ensure a reasonably level per-unit cost. Revenues are also affected in this stage. Once we patent a drug, the clock begins to tick, and we need to reduce time to market. Significantly reducing time to market will allow us to generate revenues for a longer period of time than we are currently experiencing. It would also be helpful if we could reduce the cycle time for product development. Both actions would increase revenues. Finally, we can increase revenues by increasing the volume of new products.

Johnny: There is a lot of merit to the observation that cost reduction opportunities reside mostly in product development. Once a drug is approved, its approval includes the manufacturing process. Any future changes in the manufacturing process require approval from Health Canada. Because of this, we have been reluctant, historically, to engage in process improvement or re-engineering. However, I wonder if we shouldn't reconsider this longstanding policy. Some of the quality problems we have could be corrected by changing some of our existing processes, and the costs saved may easily exceed any cost incurred from seeking Health Canada approval. I think our quality costs are at least 15 percent of sales. That's a lot of opportunity for improvement.

Kathy: I agree that cost reduction—both in the product development stage and the manufacturing stage—should be a key strategic theme. The environmental area also offers some very good opportunities. A recent pollution prevention act passed by the legislature requires that we calculate the costs of generating hazardous substances for each process. This act was the incentive we needed to begin developing an environmental cost management system. The results so far indicate that environmental costs are much more than we realized. They are estimated to be in the range of 20 to 30 percent of total operating costs. Environmental costs can be reduced by such things as computerizing chemical inventory, eliminating the use of chlorinated solvents and other hazardous materials, reducing our use of virgin feedstocks, and redesigning processes and products so that we can reduce toxic residue release. We can really have a positive environmental impact while simultaneously reducing costs if more attention is paid to environmental issues during product development.

Doreen: I like what I am hearing because I think that it also affects our ability to increase market share and revenues. For example, environmental impact is one of our major concerns. Some retail pharmacy chains pay particular attention to green products, and right now we are not competing well. Our environmental image is negative and needs to be improved. I am

convinced that doing so will allow us to increase market share. Quality is another important matter. We have had to recall two batches of products during the past two years due to poor quality, and this has hurt our image more than the environmental issue. Improving the processes to avoid these kinds of problems will save us a lot of grief. Product image and reputation are essential to increasing customer satisfaction and market share.

Tony: We started with the need to improve financial performance by increasing revenues and reducing costs. So far, we have some very good suggestions to help achieve these two objectives, but I have some concerns. First, do we have the talent and capabilities to improve quality and environmental performance? Troy, do your professionals really understand what they need to do to improve process and product designs so that we can see the desired quality and environmental improvements? Also, how can we reduce the cycle time for products and the time to market once patented?

Troy: Let me answer those question in order. First, we probably are lacking the understanding on the design issues. We will need to do some training to help our research scientists and chemical engineers understand the consequences. We may need to hire a couple of professionals who have experience in dealing with these issues. Second, we may need to make cycle time and time to market significant performance measures and reward our people for actions that reduce those measures. Our employees need to align their interests with those of the company. If we can achieve this, we should see more revenue produced per employee.

Tony: Good. Now, Johnny, tell us about production and quality. Do our manufacturing engineers and production workers need help with environmental and quality issues?

Johnny: Without question, training will be needed. Moreover, I really need to hire a couple of quality engineers.

Kathy: I also think that we need an environmental engineer with experience in pharmaceutical manufacturing processes.

Tony: Good. We certainly shouldn't ignore the necessary infrastructure to bring about the needed changes. Larry, you have been quiet, what do you think about all this? Do you have any suggestions?

Larry: Infrastructure is important. If this is all going to work, timely and accurate information will be needed. It is hard to design products and processes with cost being a significant issue without providing the right kind of cost information. We are in the process of revamping the cost management information system so that it is activity based and so that we can provide quality and environmental cost information. After listening to the comments made here, I might also suggest that we need a strategic measurement system that can be used to align the interests of our employees with our improvement strategy. People need to know what is important, that the important factors are being measured, and that they are going to be evaluated and rewarded based on these factors. Finally, I would encourage the use of target costing to help manage costs during product development. To help you all understand the importance of good information, I have assembled some activity data relating to two new products currently under development. These two products will use the same process, using different setups. The data are organized into resource, activity, and cost object modules with an accompanying list of activity drivers to facilitate the use of an ABC software package we recently acquired.

Resource Module (Projected Costs of Manufacturing Process Associated with the Two Products)

Materials	$2,000,000
Salaries and wages	1,000,000
Energy	500,000
Licence fee (environmental)	200,000
Environmental fines	400,000
Depreciation, pollution control equipment	100,000
	$4,200,000

Activity Module

	Resource Driver (Percentage Usage)				
	Materials	**Labour**	**Energy**	**Fees**	**Fines**
Supervising process*	0%	10%	0%	0%	0%
Setting up	3	20	14	0	0
Blending chemicals	80	40	30	0	0
Producing waste	10	8	10	0	0
Disposing of hazardous waste	6	12	15	40	70
Inspecting products	0	7	6	0	0
Releasing air contaminants	0	0	0	60	30
Operating pollution control equipment	1	3	25	0	0
	100%	100%	100%	100%	100%

* Secondary activity whose costs are assigned to primary activities in proportion to the labour time used.

Cost Object Module (Products and Projected Activity Usage)

Cost Objects	**Antibiotic XK1**	**Antibiotic XK5**
Expected output (kilograms)	50,000	50,000
Setup hours	12,000	7,000
Direct labour hours (blending)	24,000	16,000
Kilograms of waste	8,000	2,000
Kilograms of hazardous waste	5,000	1,000
Hours of inspection	3,000	500
Tonnes of air contaminants	4.5	0.5
Machine hours (pollution control)	2,000	500

List of Activity Drivers

Activity Drivers	**Activity Capacity**
Setup hours	20,000
Direct labour hours (blending)	40,000*
Kilograms of waste	10,000*
Kilograms of hazardous waste	8,000
Hours of inspection	4,000
Tonnes of air contaminants	5*
Machine hours (pollution control)	3,000

* Capacity is flexible (i.e., acquired as needed, and always matches usage). Capacity for other activities is acquired in advance of usage. For example, setups are acquired in units (steps) of 950 hours. Projected usage for setups equals practical capacity.

Required:

1. Use the comments from the executive meeting to identify strategic objectives and possible performance measures for each of five perspectives: financial, customer, environmental, process, and learning and growth. Would you recommend the Balanced Scorecard for Zando? Why or why not?
2. Suppose that Doreen suggested gainsharing in response to Troy's suggestion to reward product development employees for improving cycle time and time to market. What is gainsharing? How could it be used in the product development setting?
3. Determine the cost of all activities for the proposed new process. Now, assign the cost of the secondary activity to the primary activities.

4. Classify the primary activities into three categories: environmental, quality, and other (neither quality nor environmental). Did some activities end up in more than one category? Explain.
5. Calculate the cost per unit for each of the proposed products using primary activity rates. Now, calculate the *environmental* cost per unit and the *quality* cost per unit. What does this tell you about the relative desirability of the two products?
6. Following Larry's suggestion, Tony decided to use target costing to help improve new product profitability. Based on analyses by Tony and Doreen, the target prices for XK1 and XK5 are $50 per kilogram and $35 per kilogram, respectively. Tony has indicated that any new product should earn a gross profit equal to 20 percent of sales. Based on this information, answer the following:
   a. What is the target cost for each product? Given this information, what should be done?
   b. Suppose Doreen indicates that sales for each product can be increased by 50 percent if the selling price is lowered by 10 percent. Assuming the same target profit (Tony wants the original target profit per kilogram maintained), calculate the new target costs. If all non-value-added costs were eliminated, could the target be met? (Calculate the unit cost at the 50,000-unit level.) Now, calculate the effect on total profits under a scenario where non-value-added costs are not eliminated versus a scenario where all non-value-added costs are eliminated. (Include in this analysis any possible increase in sales volume.)

Glossary

Page references beginning with "18-" refer to Chapter 18, located at **www.hansen1ce.nelson.com.**

A

abnormal spoilage spoilage that exceeds the amount expected under normal efficient operating conditions. (p. 174)

absorption costing a costing method that assigns all manufacturing costs, including direct materials, direct labour, variable overhead, and a share of fixed overhead, to each unit of product. (p. 600)

absorption-costing income income computed by following a functional classification. (p. 16)

acceptable quality level (AQL) a predetermined level of defective products that a company permits to be sold. (p. 667)

account analysis method a method used to estimate costs by classifying accounts in the general ledger as fixed, variable, or mixed. (p. 66)

accounting information system a system consisting of interrelated manual and computer parts that uses processes such as collecting, recording, summarizing, analyzing (using decision models), and managing data to provide output information to users. (p. 2)

activity a basic unit of work performed within an organization. It also can be defined as an aggregation of actions within an organization useful to managers for purposes of planning, controlling, and decision making. (p. 9)

activity analysis the process of identifying, describing, and evaluating the activities an organization performs. (p. 704)

activity attributes financial and nonfinancial information items that provide descriptive labels for individual activities. (p. 273)

activity capacity the ability to perform activities or the number of times an activity can be performed. (p. 53, 717)

activity dictionary lists the activities in an organization along with desired attributes. (p. 273)

activity drivers measure the demands that cost objects place on activities. (p. 276)

activity elimination the process of eliminating non-value-added activities. (p. 707)

activity flexible budgeting the prediction of what activity costs will be as activity output changes. (p. 715)

activity inventory a listing of the activities performed within an organization. (p. 272)

activity output measure assesses the number of times the activity is performed. It is the quantifiable measure of the output. (p. 704)

activity rate the average unit cost, obtained by dividing the resource expenditure by the activity's practical capacity. (p. 56)

activity reduction decreasing the time and resources required by an activity. (p. 707)

activity resource usage model a model that classifies resources according to their nature, which allows the assessment of changes in resource supply (and thus resource spending) as activity demand for the resource changes. (p. 553)

activity selection the process of choosing among sets of activities caused by competing strategies. (p. 707)

activity sharing increasing the efficiency of necessary activities by using economies of scale. (p. 707)

activity volume variance the cost difference of the actual activity capacity acquired and the capacity that should be used. (p. 717)

activity-based costing (ABC) system a cost accounting system that uses both unit- and non-unit-based cost drivers to assign costs to cost objects by first tracing costs to activities and then tracing costs from activities to products. (p. 272)

activity-based management (ABM) an advanced control system that focuses management's attention on activities with the objective of improving the value received by the customer and the profit received by providing this value. It includes driver analysis, activity analysis, and performance evaluation and draws on activity-based costing as a major source of information. (p. 703)

activity-based responsibility accounting assigns responsibility to processes and uses both financial and nonfinancial measures of performance. (p. 723)

actual cost system a cost measurement system in which actual manufacturing costs are assigned to products. (p. 157)

adjusted cost of goods sold normal cost of goods sold adjusted to include overhead variance. (p. 171)

administrative costs all costs associated with the general administration of the organization that cannot be reasonably assigned to either marketing or production. (p. 15)

administrative expense budget a budget consisting of estimated expenditures for the overall organization and operation of the company. (p. 384)

allocation assignment of indirect costs to cost objects. (p. 11)

allocative efficiency the point at which given the mixes that satisfy the condition of technical efficiency, the least costly mix is chosen. (p. 852)

applied overhead the overhead assigned to production using a predetermined overhead rate. (p. 259)

appraisal costs costs incurred to determine whether or not products and services are conforming to requirements. (p. 783)

assets unexpired costs. (p. 9)

B

backflush costing a simplified approach for cost flow accounting that uses trigger points to determine when manufacturing costs are assigned to key inventory and temporary accounts. (p. 670)

Balanced Scorecard a strategic-based performance management system that typically identifies objectives and measures for four different perspectives: the financial perspective, the customer perspective, the process perspective, and the learning and growth perspective. (p. 751)

base period a prior period used to set the benchmark for measuring productivity changes. (p. 854)

batch production processes a process that produces batches of different products that are identical in many ways but differ in others. (p. 231)

batch-level activities activities performed each time a batch is produced. (p. 279)

benchmarking uses best practices as the standard for evaluating activity performance. (p. 713)

bill of activities specifies the product, product quantity, activity, and amount of each activity expected to be consumed by each product. (p. 278)

binding constraint constraints whose limited resources are fully used by a product mix. (p. 18-15)

break-even point the point where total sales revenue equals total costs (i.e., the point of zero profits). (p. 101)

budget a plan of action expressed in financial terms. (p. 371)

budget committee a committee responsible for setting budgetary policies and goals, reviewing and approving the budget, and resolving any differences that may arise in the budgetary process. (p. 373)

budget director the individual responsible for coordinating and directing the overall budgeting process. (p. 373)

budgetary slack the process of padding the budget by overestimating costs and underestimating revenues. (p. 409)

by-product a secondary product recovered in the course of manufacturing a primary product during a joint process. (p. 346)

C

capital expenditures budget a financial plan outlining the acquisition of long-term assets. (p. 390)

carrying costs the costs of holding inventory. (p. 18-2)

cash budget a detailed plan that outlines all sources and uses of cash. (p. 390)

causal factors activities or variables that invoke service costs. Generally, it is desirable to use causal factors as the basis for allocating service costs. (p. 317)

centralized decision making a system in which decisions are made at the top level of an organization and local managers are given the task of implementing them. (p. 491)

Certified General Accountant (CGA) a certified accountant who is permitted (by law) to serve as an external auditor. CGAs must pass a national examination and be licensed by the province in which they practice. (p. 24)

Certified Management Accountant (CMA) an accountant who has satisfied the requirements to hold a certificate in management accounting. (p. 22)

committed fixed expenses costs incurred for the acquisition of long-term activity capacity, usually as the result of strategic planning. (p. 53)

committed resources acquired as used and needed, these are a strictly variable cost. The quantity supplied equals quantity demanded, so there is no excess capacity. (p. 53)

common cost the cost of a resource used in the output of two or more services or products. (p. 314)

common fixed expenses fixed costs that are not traceable to the segments and that would remain even if one of the segments were eliminated. (p. 111)

comparable uncontrolled price method the transfer price essentially equal to the market price. (p. 517)

competitive advantage creating better customer value for the same or lower cost than can competitors or equivalent value for lower cost than can competitors. (p. 644)

confidence interval prediction interval that provides a range of values for the actual cost with a prespecified degree of confidence. (p. 65)

constant gross margin percentage method a joint cost allocation method that maintains the same gross margin percentage for each product. (p. 346)

constrained optimization choosing the optimal mix given the constraints faced by the firm. (p. 18-15)

constraint set the collection of all constraints that pertain to a particular optimization problem. (p. 18-16)

constraints a mathematical expression that expresses a resource limitation. (p. 18-15)

consumable life the length of time that a product serves the needs of a customer. (p. 657)

consumption ratio the proportion of an overhead activity consumed by a product. (p. 265)

continuous (or rolling) budget a moving 12-month budget with a future month added as the current month expires. (p. 373)

continuous improvement the relentless pursuit of improvement in the delivery of value to customers; searching for ways to increase overall efficiency by reducing waste, improving quality, and reducing costs. (p. 21, 702)

continuous replenishment when a manufacturer assumes the inventory management function for the retailer. (p. 18-9)

contribution margin the difference between revenue and all variable expenses. (p. 104)

contribution margin ratio contribution margin divided by sales revenue. It is the proportion of each sales dollar available to cover fixed costs and provide for profit. (p. 106)

contribution margin variance the difference between actual and budgeted contribution margin. (p. 609)

contribution margin volume variance the difference between the actual quantity sold and the budgeted quantity sold multiplied by the budgeted average unit contribution margin. (p. 610)

control the process of setting standards, receiving feedback on actual performance, and taking corrective action whenever actual performance deviates significantly from planned performance. (p. 371)

control activities activities performed by an organization to prevent or detect poor quality (because poor quality may exist). (p. 783)

control costs costs incurred from performing control activities. (p. 784)

control limits the maximum allowable deviation from a standard. (p. 448)

controllable costs costs that managers have the power to influence. (p. 410)

controller the chief accountant of an organization. (p. 18)

controlling the monitoring of a plan through the use of feedback to ensure that the plan is being implemented as expected. (p. 21)

conversion cost the sum of direct labour cost and overhead cost. (p. 13)

core objectives and measures those objectives and measures common to most organizations. (p. 757)

cost the cash or cash equivalent value sacrificed for goods and services that are expected to bring a current or future benefit to the organization. (p. 9)

cost accounting information system a cost management subsystem designed to assign costs to individual products and services and other objects as specified by management. (p. 9)

cost accumulation the recognition and recording of costs. (p. 156)

cost assignment the process of associating manufacturing costs with the units produced. (p. 156)

cost behaviour the way in which a cost changes in relation to changes in activity usage. (p. 46)

cost centre a responsibility centre in which a manager is responsible for cost. (p. 490)

cost leadership strategy providing the same or better value to customers at a lower cost than offered by competitors. (p. 645)

cost management identifies, collects, measures, classifies, and reports information that is useful to managers in costing (determining what something costs), planning, controlling, and decision making. (p. 2)

cost management information system an accounting information subsystem that is primarily concerned with producing outputs for internal users using inputs and processes needed to satisfy management objectives. (p. 4)

cost measurement the process of assigning dollar values to cost items. (p. 156)

cost object any item such as products, departments, projects, activities, and so on, for which costs are measured and assigned. (p. 9)

cost of goods manufactured the total cost of goods completed during the current period. (p. 16)

cost of goods sold the cost of direct materials, direct labour, and overhead attached to the units sold. (p. 16)

cost reconciliation determining whether the costs assigned to units transferred out and to units in ending work in process are equal to the costs in beginning work in process plus the manufacturing costs incurred in the current period. (p. 212)

cost-plus method a transfer price that is simply a cost-based transfer price. (p. 517)

costs of quality costs incurred because poor quality may exist or because poor quality does exist. (p. 783)

cost-volume-profit graph a graph that depicts the relationships among costs, volume, and profits. It consists of a total revenue line and a total cost line. (p. 117)

cumulative average-time learning curve model the model stating that the cumulative average time per unit decreases by a constant percentage, or learning rate, each time the cumulative quantity of units produced doubles. (p. 71)

currently attainable standard a standard that reflects an efficient operating state; it is rigorous but achievable. (p. 436)

customer perspective a Balanced Scorecard viewpoint that defines the customer and market segments in which the business will compete. (p. 757)

customer value the difference between what a customer receives (customer realization) and what the customer gives up (customer sacrifice). (p. 644, 757)

cycle time (manufacturing) the length of time required to produce one unit of a product. (p. 760)

D

decentralization the granting of decision-making freedom to lower operating levels. (p. 491)

decentralized decision making a system in which decisions are made and implemented by lower-level managers. (p. 491)

decision making the process of choosing among competing alternatives. (p. 22)

decision model a set of procedures that, if followed, will lead to a decision. (p. 550)

decline stage the stage in a product's life cycle when the product loses market acceptance and sales begin to decrease. (p. 657)

defective product a product or service that does not conform to specifications. (p. 783)

degree of operating leverage a measure of the sensitivity of profit changes to changes in sales volume. It measures the percentage change in profits resulting from a percentage change in sales. (p. 124)

dependent variable a variable whose value depends on the value of another variable. For example, Y in the cost formula $Y = F + VX$ depends on the value of X. (p. 57)

deviation the difference between the cost predicted by a cost formula and the actual cost. It measures the distance of a data point from the cost line. (p. 62)

differentiation strategy an approach that strives to increase customer value by increasing what the customer receives. (p. 645)

direct costs costs that can be easily and accurately traced to a cost object. (p. 10)

direct fixed expenses fixed costs that can be traced to each segment and would be avoided if the segment did not exist. (p. 111)

direct labour labour that is traceable to the goods or services being produced. (p. 13)

direct labour budget a budget showing the total direct labour hours needed and the associated cost for the number of units in the production budget. (p. 380)

direct labour efficiency variance (*LEV*) the difference between the actual direct labour hours used and the standard direct labour hours allowed multiplied by the standard hourly wage rate. (p. 447)

direct labour rate variance (*LRV*) the difference between the actual hourly rate paid and the standard hourly rate multiplied by the actual hours worked. (p. 447)

direct materials those materials that are traceable to the good or service being produced. (p. 13)

direct materials price variance (*MPV*) the difference between the actual price paid per unit of materials and the standard price allowed per unit multiplied by the actual quantity of materials purchased. (p. 441)

direct materials purchases budget a budget that outlines the expected usage of materials production and purchases of the direct materials required. (p. 377)

direct materials usage variance (*MUV*) the difference between the direct materials actually used and the direct materials allowed for the actual output multiplied by the standard price. (p. 441)

direct method a method that allocates service costs directly to producing departments. This method ignores any interactions that may exist among service departments. (p. 328)

direct tracing the process of identifying costs that are specifically or physically associated with a cost object. (p. 10)

discretionary fixed expenses costs incurred for the acquisition of short-term capacity or services, usually as the result of yearly planning. (p. 54)

double-loop feedback information about both the effectiveness of strategy implementation and the validity of assumptions underlying the strategy. (p. 764)

driver analysis the effort expended to identify those factors that are the root causes of activity costs. (p. 704)

driver tracing the use of drivers to assign costs to cost objects. (p. 11)

drivers factors that cause changes in resource usage, activity usage, costs, and revenues. (p. 11)

drum-buffer-rope (DBR) system the TOC inventory management system that relies on the drum beat of the major constrained resource, time buffers, and ropes to determine inventory levels. (p. 18-22)

drummer the major binding constraint. (p. 18-21)

dumping predatory pricing on the international market. (p. 594)

duration drivers measure the demands in terms of the time it takes to perform an activity, such as hours of hygienic care and monitoring hours. (p. 276)

dysfunctional behaviour individual behaviour that conflicts with the goals of the organization. (p. 407)

E

ecoefficiency a concept of sustainable development where the aim is to create more goods and services while lowering costs, using fewer resources, and creating less waste and pollution. (p. 801)

economic order quantity (EOQ) the amount that should be ordered (or produced) to minimize the total ordering (or setup) and carrying costs. (p. 18-4)

economic value added (EVA) the after-tax operating profit minus the total annual cost of capital. (p. 501)

effectiveness the manager's performance of the right activities. Measures might focus on value-added versus non-value-added activities. (p. 401, 493)

efficiency the performance of activities. May be measured by the number of units produced per hour or by the cost of those units. (p. 401, 493)

electronic data interchange (EDI) an inventory management method that allows suppliers access to a buyer's online database. (p. 18-10)

ending finished goods inventory budget a budget that describes planned ending inventory of finished goods in units and dollars. (p. 382)

environmental costs costs that are incurred because poor environmental quality exists or may exist. (p. 804)

environmental detection costs costs incurred to detect poor environmental performance. (p. 804)

environmental external failure costs costs incurred after contaminants are introduced into the environment. (p. 804)

environmental internal failure costs costs incurred after contaminants are produced but before they are introduced into the environment. (p. 804)

environmental prevention costs costs incurred to prevent damage to the environment. (p. 804)

equivalent units of output the complete units that could have been produced given the total amount of productive effort expended for the period under consideration. (p. 211)

error cause identification a program in which employees describe problems that prevent them from doing their jobs right the first time. (p. 795)

ethical behaviour choosing actions that are right, proper, and just. (p. 22)

executional activities activities that define the processes of an organization. (p. 647)

expected activity level the level of production activity expected for the coming period. (p. 160)

expected global consumption ratio the proportion of the total activity costs consumed by a given product or cost object. (p. 286)

expenses expired costs. (p. 9)

experience curve relates cost to increased efficiency, such that the more often a task is performed, the lower will be the cost of doing it. (p. 71)

external constraints limiting factors imposed on the firm from external sources. (p. 18-15)

external failure costs costs incurred because products fail to conform to requirements after being sold to outside parties. (p. 783)

external linkages the relationship of a firm's activities within its segment of the value chain with those activities of its suppliers and customers. (p. 647)

external measures measures that relate to customer and shareholder objectives. (p. 752)

F

facility-level activities activities that sustain a factory's general manufacturing processes. (p. 280)

failure activities activities performed by an organization or its customers in response to poor quality. (p. 784)

failure costs the costs incurred by an organization because failure activities are performed. (p. 784)

favourable (F) variance a variance produced whenever the actual amounts are less than the budgeted or standard allowances. (p. 441)

feasible set of solutions the collection of all feasible solutions. (p. 18-16)

feasible solution a product mix that satisfies all constraints. (p. 18-16)

feature costing assigns costs to activities and products or services based on the product's or service's features. (p. 407)

feedback information that can be used to evaluate or correct steps being taken to implement a plan. (p. 21)

FIFO costing method a unit-costing method that excludes prior-period work and costs in computing current-period unit work and costs. (p. 216)

financial accounting information system an accounting information subsystem that is primarily concerned with producing outputs for external users and uses well-specified economic events as inputs and processes that meet certain rules and conventions. (p. 4)

financial budgets that portion of the master budget that includes the cash budget, the budgeted balance sheet, the budgeted statement of cash flows, and the capital budget. (p. 373)

financial measures measures expressed in dollar terms. (p. 708, 752)

financial perspective a Balanced Scorecard viewpoint that describes the financial consequences of actions taken in the other three perspectives. (p. 755)

financial productivity measure a productivity measure in which inputs and outputs are expressed in dollars. (p. 854)

financial-based responsibility accounting system a system that assigns responsibility to organizational units and typically measures performance using only financial metrics. (p. 723)

fixed costs costs that in total are constant within the relevant range as the level of the cost driver varies. (p. 47)

fixed overhead spending variance the difference between actual fixed overhead and applied fixed overhead. (p. 458)

fixed overhead volume variance the difference between budgeted fixed overhead and applied fixed overhead; it is a measure of capacity utilization. (p. 458)

flexible budget a budget that can specify costs for a range of activity. (p. 398)

flexible budget variances the difference between actual costs and expected costs given by a flexible budget. (p. 401)

flexible resources acquired as used and needed, these are a strictly variable cost. The quantity supplied equals quantity demanded, so there is no excess capacity. (p. 53)

focusing strategy selecting or emphasizing a market or customer segment in which to compete. (p. 645)

foreign trade zones areas physically on a country's soil but considered to be outside that country's commerce. Goods imported into a foreign trade zone are duty-free until they leave the zone. (p. 552)

full environmental costing the assignment of all environmental costs, both private and societal, to products. (p. 809)

full private costing the assignment of only private costs to individual products. (p. 809)

full-costing income see **absorption-costing income**. (p. 16)

G

gainsharing an incentive plan used to enhance productivity by linking compensation bonuses directly to a team's performance. (p. 797)

goal congruence the alignment of a manager's personal goals with those of the organization. (p. 407, 493)

goodness of fit the degree of association between Y and X (cost and activity). It is measured by how much of the total variability in Y is explained by X. (p. 65)

growth stage the stage in a product's life cycle when sales increase at an increasing rate. (p. 657)

H

heterogeneity refers to the greater chances for variation in the performance of services than in the production of products. (p. 152)

hidden quality costs opportunity costs resulting from poor quality. (p. 784)

high-low method a method for fitting a line to a set of data points using the high and low points in the data set. For a cost formula, the high and low points represent the high and low activity levels. It is used to break out the fixed and variable components of a mixed cost. (p. 58)

hypothesis test of cost parameters a statistical assessment of a cost formula's reliability that indicates whether the parameters are different from zero. (p. 65)

hypothetical sales value an approximation of the sales value of a joint product at split-off. It is found by subtracting all separable (or further) processing costs from the eventual market value. (p. 344)

I

ideal standards standards that reflect perfect operating conditions. (p. 436)

incentives the positive or negative measures taken by an organization to induce a manager to exert effort toward achieving the organization's goals. (p. 408)

incremental approach the practice of taking the prior year's budget and adjusting it upward or downward to determine next year's budget. (p. 397)

incremental unit-time learning curve model decreases by a constant percentage each time the cumulative quantity of units produced doubles. (p. 73)

independent variable a variable whose value does not depend on the value of another variable. For example, in the cost formula $Y = F + VX$, the variable X is an independent variable. (p. 57)

indirect costs costs that cannot be traced to a cost object. (p. 10)

indirect materials direct materials that form an insignificant part of the final product. (p. 13)

industrial engineering method a forward-looking method of determining through physical observation and analysis, just what activities, in what amounts, are needed to complete a process. (p. 66)

industrial value chain the linked set of value-creating activities from basic raw materials to end-use customers. (p. 646)

innovation process a process that anticipates the emerging and potential needs of customers and creates new products and services to satisfy those needs. (p. 759)

inseparability an attribute of services that means that production and consumption are inseparable. (p. 12, 152)

intangibility refers to the nonphysical nature of services as opposed to products. (p. 12, 152)

intercept parameter the fixed cost, representing the point where the cost formula intercepts the vertical axis. In the cost formula $Y = F + VX$, F is the intercept parameter. (p. 57)

interim quality performance report a comparison of current actual quality costs with short-term budgeted quality targets. (p. 795)

interim quality standards a standard based on short-run quality goals. (p. 794)

internal business process perspective a Balanced Scorecard viewpoint that describes the internal processes needed to provide value for customers and owners. (p. 759)

internal constraints limiting factors found within the firm. (p. 18-15)

internal failure costs costs incurred because products and services fail to conform to requirements where lack of conformity is discovered prior to external sale. (p. 783)

internal linkages relationships among activities within a firm's value chain. (p. 647)

internal measures measures that relate to the processes and capabilities that create value for customers and shareholders. (p. 752)

introduction stage a product life-cycle stage characterized by preproduction and startup activities, where the focus is on obtaining a foothold in the market. (p. 657)

inventory the money an organization spends in turning raw materials into throughput. (p. 18-20)

investment centre a responsibility centre in which a manager is responsible for revenues, costs, and investments. (p. 490)

J

JIT purchasing a system that requires suppliers to deliver parts and materials just in time to be used in production. (p. 665, 844)

job-order cost sheet a document or record used to accumulate manufacturing costs for a job. (p. 161)

job-order costing system a cost accumulation method that accumulates manufacturing costs by job. (p. 161)

joint products two or more products, each having relatively substantial value, that are produced simultaneously by the same process up to a "split-off" point. (p. 337)

just-in-case inventory management a traditional inventory model based on anticipated demand. (p. 18-1)

just-in-time inventory management the continual pursuit of productivity through the elimination of waste. (p. 18-8)

just-in-time (JIT) manufacturing a demand-pull system that strives to produce a product only when it is needed and only in the quantities demanded by customers. (p. 8, 665)

K

kaizen costing efforts to reduce the costs of existing products and processes. (p. 707)

kaizen standard an interim standard that reflects the planned improvement for a coming period. (p. 436, 712)

Kanban system an information system that controls production on a demand-pull basis through the use of cards or markers. (p. 18-11)

keep-or-drop decision a relevant costing analysis that focuses on keeping or dropping a segment of a business. (p. 558)

L

lag measures outcome measures or measures of results from past efforts. (p. 752)

lead measures (performance drivers) factors that drive future performance. (p. 752)

lead time for purchasing, the time to receive an order after it is placed. For manufacturing, the time to produce a product from start to finish. (p. 18-4)

lean manufacturing an approach designed to eliminate waste and maximize customer value; characterized by delivering the right product, in the right quantity, with the right quality (zero-defect), at the exact time the customer needs it and at the lowest possible cost. (p. 839)

learning and growth (infrastructure) perspective a Balanced Scorecard viewpoint that defines the capabilities that an organization needs to create long-term growth and improvement. (p. 763)

learning curve an important type of nonlinear cost curve that shows how the labour hours worked per unit decrease as the volume produced increases. (p. 70)

learning rate expressed as a percent, it gives the percentage of time needed to make the next unit, based on the time it took to make the previous unit. (p. 71)

life-cycle cost assessment assigning costs and benefits to environmental consequences and improvements. (p. 657)

life-cycle cost management actions taken that cause a product to be designed, developed, produced, marketed, distributed, operated, maintained, serviced, and disposed of so that life-cycle profits are maximized. (p. 658)

linear programming a method that searches among possible solutions until it finds the optimal solution. (p. 18-16)

linear programming model expresses a constrained optimization problem as a linear objective function subject to a set of linear constraints. (p. 18-15)

long run period of time for which all costs are variable (i.e., there are no fixed costs). (p. 52)

long-range quality performance report a performance report that compares current actual quality costs with long-range targeted quality costs (usually in the 2%–3% range). (p. 795)

loose constraints constraints whose limited resources are not fully used by a product mix. (p. 18-15)

loss a cost that expires without producing any revenue benefit; a negative profit. (p. 9)

M

make-or-buy decision a decision that focuses on whether a component (service) should be made (provided) internally or purchased externally. (p. 555)

manufacturing cells a plant layout containing machines grouped in families, usually in a semicircle. (p. 666, 842)

margin the ratio of net operating income to sales. (p. 494)

margin of safety the units sold or expected to be sold or sales revenue earned or expected to be earned above the break-even volume. (p. 122)

market share the proportion of industry sales accounted for by a company. (p. 613)

market share variance the difference between the actual market share percentage and the budgeted market share percentage multiplied by actual industry sales in units times budgeted average unit contribution margin. (p. 613)

market size the total revenue for the industry. (p. 613)

market size variance the difference between actual and budgeted industry sales in units multiplied by the budgeted market share percentage times the budgeted average unit contribution margin. (p. 613)

marketing expense budget a budget that outlines planned expenditures for selling and distribution activities. (p. 384)

marketing (selling) costs those costs necessary to market and distribute a product or service. (p. 15)

markup a percentage applied to base cost for the purpose of calculating price; the markup includes desired profit and any costs not included in the base. (p. 590)

master budget the collection of all area and activity budgets representing a firm's comprehensive plan of action. (p. 373)

materials requisition form a document used to identify the cost of raw materials assigned to each job. (p. 162)

maturity stage the stage in a product's life cycle when sales increase at a decreasing rate. (p. 657)

maximum transfer price the transfer price that will make the buying division no worse off if an input is acquired internally. (p. 509)

method of least squares a statistical method to find a line that best fits a set of data. It is used to break out the fixed and variable components of a mixed cost. (p. 62)

minimum transfer price the transfer price that will make the selling division no worse off if the intermediate product is sold internally. (p. 509)

mix variance the difference in the standard cost of the mix of actual material inputs and the standard cost of the material input mix that should have been used. (p. 464)

mixed costs costs that have both a fixed and a variable component. (p. 51)

monopolistic competition a market that is close to the competitive market. There are many sellers and buyers, low barriers to entry, but the products are differentiated on some basis. (p. 589)

monopoly a market in which barriers to entry are so high that there is only one firm selling a unique product. (p. 589)

multinational corporation (MNC) a corporation for which a significant amount of business is done in more than one country. (p. 491)

multiple regression the use of least-squares analysis to determine the parameters in a linear equation involving two or more explanatory variables. (p. 70)

multiple-period quality trend report a graph that plots quality costs (as a percentage of sales) against time. (p. 795)

myopic behaviour managerial actions that improve budgetary performance in the short run at the expense of the long-run welfare of the organization. (p. 410, 498)

N

net income operating income less taxes, interest expense, and research and development expense. (p. 102)

net realizable value method a method of allocating joint production costs to the joint products based on their proportionate share of eventual revenue less further processing costs. (p. 344)

nonfinancial measures measures expressed in nonmonetary units. (p. 752)

nonproduction costs those costs associated with the functions of selling and administration. (p. 12)

non-unit-based drivers factors, other than the number of units produced, that measure the demands that cost objects place on activities. (p. 263)

non-unit-level drivers explain the changes in cost as factors other than units change. (p. 46)

non-value-added activities activities either unnecessary or necessary but inefficient and improvable. (p. 705)

non-value-added costs costs that are caused either by non-value-added activities or by the inefficient performance of value-added activities. (p. 706)

normal activity level the average activity level that a firm experiences over more than one fiscal period. (p. 160)

normal cost of goods sold the cost of goods sold figure obtained when the per-unit normal cost is used. (p. 171)

normal costing system a cost measurement system in which the actual costs of direct materials and direct labour are assigned to production and a predetermined rate is used to assign overhead costs to production. (p. 158, 259)

normal spoilage spoilage that is expected with an efficient production process and that may require extra work to make the units saleable, or may result in the units being discarded. (p. 174)

O

objective function the function to be optimized, usually a profit function; thus, optimization usually means maximizing profits. (p. 18-15)

objective measures measures that can be readily quantified and verified. (p. 752)

observable quality costs those quality costs that are available from an organization's accounting records. (p. 784)

oligopoly a market structure characterized by a few sellers and high barriers to entry. (p. 589)

operating assets those assets used to generate operating income, consisting usually of cash, inventories, receivables, property, plant, and equipment. (p. 494)

operating budgets budgets associated with the income-producing activities of an organization. (p. 373)

operating expenses the money an organization spends in turning inventories into throughput. (p. 18-20)

operating income revenues minus expenses from the firm's normal operations. Income taxes are excluded. (p. 102, 494)

operating leverage the use of fixed costs to extract higher percentage changes in profits as sales activity changes. Leverage is achieved by increasing fixed costs while lowering variable costs. (p. 123)

operation costing a costing system that uses job-order costing to assign materials costs and process costing to assign conversion costs. (p. 155, 232)

operational activities day-to-day activities performed as a result of the structure and processes selected by an organization. (p. 648)

operational cost drivers those factors that drive the cost of operational activities. (p. 648)

operational productivity measure measures that are expressed in physical terms. (p. 853)

operations process a process that produces and delivers existing products and services to customers. (p. 759)

opportunity cost approach a transfer pricing system that identifies the minimum price that a selling division would be willing to accept and the maximum price that a buying division would be willing to pay. (p. 509)

ordering costs the costs of placing and receiving an order. (p. 18-2)

organizational cost drivers structural and procedural factors that determine the long-term cost structure of an organization. (p. 647)

outsourcing the payment by a company for a business function that was formerly done in-house. (p. 555)

overapplied overhead the overhead variance resulting when applied overhead is greater than the actual overhead cost incurred. (p. 261)

overhead all production costs other than direct materials and direct labour. (p. 13)

overhead budget a budget that reveals the planned expenditures for all indirect manufacturing items. (p. 380)

overhead variance the difference between the actual overhead and the applied overhead. (p. 261)

P

partial productivity measurement a ratio that measures productive efficiency for one input. (p. 853)

participative budgeting an approach to budgeting that allows managers who will be held accountable for budgetary performance to participate in the budget's development. (p. 408)

penetration pricing the pricing of a new product at a low initial price, perhaps even lower than cost, to build market share quickly. (p. 593)

perfectly competitive market a market (or industry) characterized by many buyers and sellers—no one of which is large enough to influence the market—a homogeneous product, and easy entry into and exit from the industry. (p. 589)

performance reports accounting reports that provide feedback to managers by comparing planned outcomes with actual outcomes. (p. 21)

period costs costs such as marketing and administrative costs that are expensed in the period in which they are incurred. (p. 15)

perishability an attribute of services that means that they cannot be inventoried but must be consumed when performed. (p. 12, 152)

perquisites a type of fringe benefit over and above salary that is received by managers. (p. 505)

physical flow schedule a schedule that accounts for all units flowing through a department during a period. (p. 212)

physical units method a method of allocating joint production costs based on each product's share of total units. (p. 338)

planning setting objectives and identifying methods to achieve those objectives. (p. 21)

post-purchase costs the costs of using, maintaining, and disposing of a product incurred by the customer after purchasing a product. (p. 644, 757)

post-sales service process a process that provides critical and responsive service to customers after the product or service has been delivered. (p. 760)

practical activity level the output a firm can achieve if it is operating efficiently. (p. 160)

practical capacity the efficient level of activity performance. (p. 53)

predatory pricing the practice of setting prices below cost for the purpose of injuring competitors and eliminating competition. (p. 593)

predetermined overhead rate estimated overhead divided by the estimated level of production activity. It is used to assign overhead to production. (p. 160, 259)

prevention costs costs incurred to prevent defects in products or services being produced. (p. 783)

price discrimination charging different prices to different customers for essentially the same commodity. (p. 594)

price elasticity of demand measured as the percentage change in quantity divided by the percentage change in price. (p. 588)

price gouging when firms with market power (i.e., little or no competition) price products "too high." (p. 593)

price skimming a pricing strategy in which a higher price is charged at the beginning of a product's life cycle, then lowered at later phases of the life cycle. (p. 593)

price standards the price that should be paid per unit of input. (p. 436)

price (rate) variance the difference between standard price and actual price multiplied by the actual quantity of inputs used. (p. 440)

price volume variance the difference between actual volume sold and expected volume sold multiplied by the expected price. (p. 609)

price-recovery component the difference between the total profit change and the profit-linked productivity change. (p. 856)

primary activity an activity that is consumed by a product or customer (i.e., a final cost object). (p. 273)

prime cost the sum of direct materials cost and direct labour cost. (p. 13)

private costs environmental costs that an organization has to pay. (p. 805)

process a series of activities (operations) that are linked to perform a specific objective. (p. 204)

process creation installing an entirely new process to meet customer and financial objectives. (p. 725)

process improvement incremental and constant increases in the efficiency of an existing process. (p. 724)

process innovation (business re-engineering) the performance of a process in a radically new way with the objective of achieving dramatic improvements in response time, cost, quality, and other important competitive factors. (p. 724)

process value analysis (PVA) an analysis that defines activity-based responsibility accounting, focuses on accountability for

activities rather than costs, and emphasizes the maximization of system-wide performance instead of individual performance. (p. 704)

process value chain the innovation, operations, and post-sales service processes. (p. 759)

process-costing principle the period's unit cost is computed by dividing the costs of the period by the output of the period. (p. 210)

producing departments a unit within an organization responsible for producing the products or services that are sold to customers. (p. 315)

product diversity the situation present when products consume overhead in different proportions. (p. 265)

product life cycle the time a product exists—from conception to abandonment; the profit history of the product according to four stages: introduction, growth, maturity, and decline. (p. 597, 655)

product-level activities activities performed that enable the various products of a company to be produced. (p. 279)

production budget a budget that shows how many units must be produced to meet sales needs and satisfy ending inventory requirements. (p. 377)

production (or product) costs those costs associated with the manufacture of goods or the provision of services. (p. 12)

production Kanban a card or marker that specifies the quantity the preceding process should produce. (p. 18-11)

production report a report that summarizes the manufacturing activity for a department during a period and discloses physical flow, equivalent units, total costs to account for, unit cost computation, and costs assigned to goods transferred out and to units in ending work in process. (p. 208)

productivity producing output efficiently, using the least quantity of inputs possible. (p. 852)

productivity measurement assessment of productivity changes. (p. 852)

profile measurement a series or vector of separate and distinct partial operational measures. (p. 855)

profit centre a responsibility centre in which a manager is responsible for both revenues and costs. (p. 490)

Profit-Linkage Rule for the current period, calculate the cost of the inputs that would have been used in the absence of any productivity change and compare this cost with the cost of the inputs actually used. The difference in costs is the amount by which profits changed because of productivity changes. (p. 856)

profit-linked productivity measurement an assessment of the amount of profit change—from the base period to the current period—attributable to productivity changes. (p. 856)

profit-volume graph a graphical portrayal of the relationship between profits and sales activity. (p. 116)

pseudoparticipation a budgetary system in which top management solicits inputs from lower-level managers and then ignores those inputs. Thus, in reality, budgets are dictated from above. (p. 409)

Q

quality of conformance conforming to the design requirements of the product. (p. 782)

quality product or service a product that meets or exceeds customer expectations. (p. 782)

quantity standards the quantity of input allowed per unit of output. (p. 436)

R

realized external failure costs the environmental costs caused by environmental degradation and paid for by the responsible organization. (p. 804)

reciprocal method a method that simultaneously allocates service costs to all user departments. It gives full consideration to interactions among service departments. (p. 330)

relevant costs (revenues) future costs (revenues) that differ across alternatives. (p. 551)

relevant range the range over which an assumed cost relationship is valid for the normal operations of a firm. (p. 47, 119)

reorder point the point in time at which a new order (or setup) should be initiated. (p. 18-4)

resale price method computes a transfer price equal to the sales price received by the reseller less an appropriate markup. (p. 517)

research and development expense budget a budget that outlines planned expenditures for research and development. (p. 385)

residual income the difference between operating income and the minimum required dollar return on a company's operating assets. (p. 498)

resource drivers factors that measure the demands placed on resources by activities and are used to assign the cost of resources to activities. (p. 275)

responsibility accounting a system that measures the results of each responsibility centre and compares those results with some measure of expected or budgeted outcome. (p. 490, 723)

responsibility centre a segment of the business whose manager is accountable for specified sets of activities. (p. 489)

return on investment (ROI) the ratio of operating income to average operating assets. (p. 494)

revenue centre a responsibility centre in which a manager is responsible only for sales. (p. 490)

revenue-producing life the time a product generates revenue for a company. (p. 657)

robustness exact conformance to the target value (no tolerance allowed). (p. 783)

ropes actions taken to tie the rate at which raw material is released into the plant (at the first operation) to the production rate of the constrained resource. (p. 18-22)

S

safety stock extra inventory carried to serve as insurance against fluctuations in demand. (p. 18-4)

sales budget a budget that describes expected sales in units and dollars for the coming period. (p. 377)

sales mix the relative combination of products (or services) being sold by an organization. (p. 112)

sales mix variance the sum of the change in units for each product multiplied by the difference between the budgeted contribution margin and the budgeted average unit contribution margin. (p. 613)

sales price variance the difference between actual price and expected price multiplied by the actual quantity or volume sold. (p. 609)

sales-revenue approach an approach to CVP analysis that uses sales revenue to measure sales activity. Variable costs and contribution margin are expressed as percentages of sales revenue. (p. 107)

sales-value-at-split-off method a method of allocating joint production costs based on each product's share of revenue realized at the split-off point. (p. 342)

scattergraph a plot of (X, Y) data points. For cost analysis, X is activity usage and Y is the associated cost at that activity level. (p. 58)

scatterplot method a method to fit a line to a set of data using two points that are selected by judgment. It is used to break out the fixed and variable components of a mixed cost. (p. 58)

secondary activity an activity that is consumed by intermediate cost objects such as materials and primary activities. (p. 273)

sell or process further relevant costing analysis that focuses on whether or not a product should be processed beyond the split-off point. (p. 562)

sensitivity analysis a "what-if" technique that examines altering certain key variables to assess the effect on the original outcome. (p. 124)

separable costs costs incurred beyond the split-off point that can be assigned to specific products identified at the split-off point. (p. 337)

sequential (or step) method a method that allocates service costs to user departments in a sequential manner. It gives partial consideration to interactions among service departments. (p. 328)

services a task or activity performed for a customer or an activity performed by a customer using an organization's products or facilities. (p. 11)

setup costs the costs of preparing equipment and facilities so that they can be used for production. (p. 18-2)

shadow price the amount by which throughput will increase for one additional unit of scarce resource. (p. 18-17)

short run period of time in which at least one cost is fixed. (p. 52)

simplex method an algorithm that identifies the optimal solution for a linear programming problem. (p. 18-17)

single-loop feedback information about the effectiveness of strategy implementation. (p. 764)

slope parameter the variable cost per unit of activity usage, represented by V in the cost formula $Y = F + VX$. (p. 57)

source document a document that describes a transaction and is used to keep track of costs as they occur. (p. 156)

special-order decisions decisions that focus on whether a specially priced order should be accepted or rejected. (p. 562)

split-off point the point at which the joint products become separate and identifiable. (p. 337)

standard bill of materials a listing of the type and quantity of materials allowed for a given level of output. (p. 444)

standard cost per unit the per-unit cost that should be achieved given materials, labour, and overhead standards. (p. 438)

standard cost sheet a listing of the standard costs and standard quantities of direct materials, direct labour, and overhead that should apply to a single product. (p. 438)

standard hours allowed the direct labour hours that should have been used to produce the actual output (Unit labour standard $\times$ Actual output). (p. 439)

standard quantity of materials allowed the quantity of materials that should have been used to produce the actual output (Unit materials standard $\times$ Actual output). (p. 439)

static budget a budget for a particular level of activity. (p. 397)

step-cost function a cost function in which cost is defined for ranges of activity usage rather than point values. The function has the property of displaying constant cost over a range of activity usage and then changing to a different cost level as a new range of activity usage is encountered. (p. 54)

step-fixed costs a step-cost function in which cost remains constant over wide ranges of activity usage. (p. 55)

step-variable costs a step-cost function in which cost remains constant over relatively narrow ranges of activity. (p. 54)

stock option the right to purchase a certain amount of stock at a fixed price. (p. 506)

stock-out costs the costs of insufficient inventory. (p. 18-2)

strategic cost management the use of cost data to develop and identify superior strategies that will produce a sustainable competitive advantage. (p. 644)

strategic decision making choosing among alternative strategies with the goal of selecting a strategy or strategies that provide a company with reasonable assurance of long-term growth and survival. (p. 644)

strategic positioning the process of selecting the optimal mix of cost leadership, differentiation, and focusing strategies. (p. 645)

strategic-based responsibility accounting system (strategic-based performance management system) a responsibility accounting system that translates an organization's mission and strategy into operational objectives and measures for four different perspectives: the financial perspective, the customer perspective, the process perspective, and the learning and growth (infrastructure) perspective. (p. 751)

strategy choosing the market and customer segments, identifying critical internal business processes at which the firm must excel to increase customer value, and selecting the individual and organizational capabilities required to achieve the firm's internal, customer, and financial objectives. (p. 645, 755)

strategy map a detailed graphical representation of an organization's strategic objectives and the cause-and-effect relationships that exist among them. (p. 765)

stretch targets targets that are set at levels that, if achieved, will transform the organization within a period of three to five years. (p. 754)

structural activities activities that determine the underlying economic structure of the organization. (p. 647)

subjective measures measures that are nonquantifiable whose values are judgmental in nature. (p. 752)

sunk cost a past cost—a cost already incurred. (p. 551)

supplies materials necessary for production but that do not become part of the finished product or are not used in providing a service. (p. 13)

support departments a unit within an organization that provides essential support services for producing departments. (p. 315)

sustainable development development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (p. 801)

system a set of interrelated parts that performs one or more processes to accomplish specific objectives. (p. 3)

T

tactical cost analysis the use of relevant cost data to identify the alternative that provides the greatest benefit to the organization. (p. 550)

tactical decision making choosing among alternatives with only an immediate or limited end in view. (p. 548)

Taguchi loss function a function that assumes any variation from the target value of a quality characteristic causes hidden quality costs. (p. 785)

tangible products goods produced by converting raw materials through the use of labour and capital inputs such as plant, land, and machinery. (p. 11)

target cost the difference between the sales price needed to achieve a projected market share and the desired per-unit profit. (p. 662)

target costing a method of determining the cost of a product or service based on the price that customers are willing to pay. Also referred to as price-driven costing. (p. 592)

tariff the tax on imports levied by the federal government. (p. 552)

technical efficiency point at which for any mix of inputs that will produce a given output, no more of any one input is used than is absolutely necessary. (p. 852)

testable strategy set of linked objectives aimed at an overall goal that can be restated into a sequence of cause-and-effect hypotheses. (p. 764)

theoretical activity level the maximum output possible for a firm under perfect operating conditions. (p. 160)

theory of constraints method used to continuously improve manufacturing activities and nonmanufacturing activities. (p. 8, 18-17)

throughput the rate at which an organization generates money through sales. (p. 18-19)

time buffer the inventory needed to keep the constrained resource busy for a specified time interval. (p. 18-21)

time ticket a document used to identify the cost of direct labour for a job. (p. 163)

Time-Driven Activity-Based Costing (TDABC) a before-the-fact simplification method that simplifies Stage 1 by eliminating the need for detailed interviewing and surveying to determine resource drivers. (p. 280)

total budget variance the difference between the actual cost of an input and its planned cost. (p. 439)

total (overall) sales variance the sum of the sales price and sales volume variances. (p. 609)

total preventive maintenance a program of preventive maintenance that has zero machine failures as its standard. (p. 18-11)

total product the complete range of tangible and intangible benefits a customer receives from a product. (p. 644)

total productive efficiency the point at which technical and price efficiency are achieved. (p. 852)

total productivity measurement an assessment of productive efficiency for all inputs combined. (p. 855)

total quality management (TQM) a philosophy that requires managers to strive to create an environment that will enable workers to manufacture perfect (zero defects) products. (p. 652)

traceability the ability to assign a cost directly to a cost object in an economically feasible way using a causal relationship. (p. 10)

transaction drivers measure the number of times an activity is performed, such as the number of treatments and the number of requests. (p. 276)

transfer prices the price charged for goods transferred from one division to another. (p. 508)

transfer pricing problem the problem of finding a transfer pricing system that simultaneously satisfies the three objectives of accurate performance evaluation, goal congruence, and autonomy. (p. 509)

transferred-in cost the cost of goods transferred in from a prior process. (p. 205)

treasurer the financial officer responsible for the management of cash and investment capital. (p. 21)

turnover a measure that is found by dividing sales by average operating assets to show how productively assets are being used to generate sales. (p. 494)

U

underapplied overhead the overhead variance resulting when the actual overhead cost incurred is greater than the applied overhead. (p. 261)

unfavourable (U) variance a variance produced whenever the actual input amounts are greater than the budgeted or standard allowances. (p. 441)

unit standard cost the product of these two standards: Standard price × Standard quantity ($SP \times SQ$). (p. 436)

unit-based drivers explain changes in cost as units produced change. (p. 259)

unit-level activities activities that are performed each time a unit is produced. (p. 279)

unit-level drivers activity drivers that explain changes in cost as units produced change. (p. 46)

unrealized external failure (societal) costs environmental costs caused by an organization but paid for by society. (p. 804)

unused capacity the difference between the acquired activity capacity and the actual activity usage. (p. 53)

unused capacity variance the difference between acquired capacity (practical capacity) and actual capacity. (p. 717)

usage (efficiency) variance the difference between standard quantities and actual quantities multiplied by standard price. (p. 440)

V

value chain the set of activities required to design, develop, produce, market, distribute, and service a product (the product can be a service). (p. 5)

value stream made up of value-added and non-value-added activities required to bring a product group or service from its starting point to a finished product in the hands of the customer. (p. 840)

value-added activities activities that are necessary to achieve corporate objectives and remain in business. (p. 705)

value-added costs costs caused by value-added activities. (p. 705)

value-added standard the optimal output level for an activity. (p. 708)

value-chain analysis identifying and exploiting internal and external linkages with the objective of strengthening a firm's strategic position. (p. 644)

variable budget (p. 401) see **flexible budget**.

variable cost ratio variable costs divided by sales revenue. It is the proportion of each sales dollar needed to cover variable costs. (p. 106)

variable costing a costing method that assigns only variable manufacturing costs to the product; these costs include direct materials, direct labour, and variable overhead. Fixed overhead is treated as a period cost and is expensed in the period incurred. (p. 603)

variable costs costs that in total vary in direct proportion to changes in a cost driver. (p. 48)

variable overhead efficiency variance the difference between the actual direct labour hours used and the standard hours allowed multiplied by the standard variable overhead rate. (p. 454)

variable overhead spending variance the difference between the actual variable overhead and the budgeted variable overhead based on actual hours used to produce the actual output. (p. 453)

velocity the number of units that can be produced in a given period of time (e.g., output per hour). (p. 760)

vendor Kanban a card or marker that signals to a supplier the quantity of materials that need to be delivered and the time of delivery. (p. 18-11)

W

waste anything customers do not value. (p. 845)

weight factor a value used to assign weights to various joint products in accordance with their relative size, difficulty to produce, etc. (p. 340)

weighted average cost of capital the proportionate share of each method of financing is multiplied by its percentage cost and summed. (p. 501)

weighted average costing method a unit-costing method that merges prior-period work and costs with current-period work and costs. (p. 222)

withdrawal Kanban a marker or card that specifies the quantity that a subsequent process should withdraw from a preceding process. (p. 18-11)

work in process consists of all partially completed units found in production at a given point in time. (p. 16)

work orders used to collect production costs for product batches and to initiate production. (p. 232)

work-in-process inventory file the collection of all job cost sheets. (p. 162)

Y

yield variance the difference in the standard material cost of the standard yield and the standard material cost of the actual yield. (p. 464)

Z

zero defects a quality performance standard that requires all products and services to be produced and delivered according to specifications. (p. 783)

zero-base budgeting a method of budgeting in which the prior year's budgeted level is not taken for granted. Existing operations are analyzed, and continuance of the activity or operation must be justified on the basis of its need or usefulness to the organization. (p. 397)

Check Figures

Check figures are given for selected exercises and problems.

Chapter 1

1-13 2. Cost of goods manufactured = $725,000
3. Conversion cost = $53.90

1-14 1. Ending inventory = $42,000
3. Cost of goods manufactured = $41,250
5. Overhead = $156,900

1-15 1. Cost of goods manufactured = $769,600
2. Cost of goods sold = $759,600

1-16 1. Finished goods ending inventory = $274,750
2. Cost of goods sold = $3,493,250
3. Operating income = $653,450

1-17 1. Cost of goods manufactured = $801,560
2. Cost of goods sold = $756,860

1-18 5. Operating income = $4,645

1-20 2. Cost of goods manufactured = $965,000
3. Conversion cost = $16.10

1-21 2. Operating income = $ 186,500

1-22 3. Total overhead = $300,000
4. Cost of goods manufactured = $706,000
5. Cost of goods sold = $708,000
6. Operating income = $122,200, 10.18%

1-23 1. Cost of goods manufactured = $5,018,000
3. Operating income = $1,048,250, 15.25%

1-24 1. Cost of goods manufactured = $295,000
2. Cost of goods sold = $236,000

1-25 1. Cost of services sold = $1,577,500
3. Operating income = $650,500

1-26 1. Cost of goods manufactured = $356,200
2. Operating income = $334,000

Chapter 2

2-9 3. Total fixed overhead cost = $720,000
6. Unit fixed cost = $28.80 per client

2-12 2. Fixed activity rate = $2.661 per test

2-14 3. April cost = $4,214

2-17 2. Y = $174,768.82

2-18 3. Y = $94,140

2-19 1. Y = $9,344 + 8.30X$

2-20 2. Y = $5,791

2-21 2. Y = $379,842

2-23 2. Total labour cost for 16 sets = $202,502

2-26 4. Charge/day = $124.80

2-28 1. Total unit variable cost = $210
3. Total unit variable cost = $222

2-30 3. Y = $91,815
4. Y = $87,195

2-31 2. Y = $63,696
3. Y = $69,101

2-32 1. Y = $9,025
2. Y = $9,227
4. Y = $9,375.80

2-33 2. Y = $34,895.70

Chapter 3

3-8 1. Contribution margin = $7.20
3. Operating income = $19,440

3-9 1. Break-even in units = 36,000
2. Operating income = $2,775,000

3-10 1. Contribution margin ratio = 80%
3. Sales revenue for target profit = $10,812,500

3-11 1. Break-even in units = 18,000
2. Operating income = $46,000

3-12 1. Break-even in units = 68 jobs per month
4. Break-even in units = 50 jobs per month

3-13 1. Break-even sales revenue = $4,140,000
2. Margin of safety = $6,640,000

3-14 1. Net income after taxes = $627,900

3-15 1. Break-even in units = 30

3-17 1. Contribution margin ratio = 0.25
3. Operating income = $14,880
4. Margin of safety = $59,520

3-19 2. Revenue = $13,071,895

3-20 1. Break-even in units = 400,000
3. Break-even in units = 292,858

3-21 1. Operating income = $139,000
3. Break-even sales = $513,889

3-22 1. (a) Operating income = $1,025,000

3-24 3. Margin of safety = $256,140
4. Net income = $120,000

3-25 3. New break-even in units = 87,805
5. New break-even in units = 127,778

3-26 3. Margin of safety = $500,000

3-27 2. Operating income = $1,292,800
5. Margin of safety = $6,481,818
3-28 2. Revenue = $584,735
4. Revenue = $1,311,386
3-29 3. Percentage change in net income = 160%
3-30 3. Net income = $119,900
3-31 2. Total unit variable cost = $21

Chapter 4

4-7 2. Total cost = $4,130
4-8 2. Total unit cost: June = $776, July = $701, August = $607
4-11 1. Job 78: Total job cost = $6,408
2. Job 80: Ending Work in Process = $9,060
4-12 3. Ending Work in Process = $52,075
4. Cost of goods sold = Job 115 = $24,180
5. Price of Job 115 = $29,016
4-14 3. Work in process, August 31 = $12,345
4. Cost of goods sold = $19,324
5. August sales revenue = $28,986
4-15 Operating income = $7,802
4-16 2. (d) Finished Goods Inventory = $1,630
4-17 2. Ending Work in Process = $2,500
4-18 2. Ending Work in Process = $12,890
4-20 3. Ending Work in Process = $72,750
4. Cost of goods sold = $258,988
4-21 3. Cost of goods manufactured = $160,000
4-22 1. Bid price: Job 1 = $8,890, Job 2 = $16,926
2. Bid price: Job 1 = $9,821, Job 2 = $17,136
4-24 1. Unit bid price: Job 97-28 = $18.75, Job 97-35 = $60.00
2. Unit bid price: Job 97-28 = $14.67, Job 97-35 = $101.01
4-25 1. Total cost = $47.50
4. Price = $641.25
4-26 1. Total cost = $45.00
2. Total cost = $51.00
4-27 4. Profit = $18,951
4-28 1. Gross profit = $19
4-29 2. Gross profit = $644.46
4. Total price = $2,980.25

Chapter 5

5-12 2. Cost per haircut = $10
5-13 2. Unit cost = $11 per unit
5-14 4. (c) Cost of EWIP = $280,000
5-15 Total costs accounted for = $5,364,000
5-16 1. Total units accounted for = 135,000
5-17 1. Total cost of goods transferred out = $251,000
2. Total units accounted for = 38,000
5-20 2. Cost of goods transferred out = $68,750
5-21 1. Total units accounted for = 70,000
2. Unit cost = $10.40 per equivalent unit
5-26 1. Total units accounted for = 135,000
3. Conversion cost = $5,871,150
5-27 3. Total unit cost = $77.420
5-28 Total costs accounted for = $246,240
5-29 Total costs accounted for = $246,000
5-35 2. Unit cost: Regular strength = $2.17, Extra strength = $2.17
5-37 2. Total unit cost = $8.50
3. Cost of units transferred out = $2,975,000
5-38 3. Total unit cost = $0.39
4. Loss due to spoilage = $390

Chapter 6

6-10 3. Underapplied overhead = $11,600
4. Unit cost = $8.8536
6-11 2. Jackson: Underapplied overhead = $2,380
Jalil: Overapplied overhead = $3,750
6-12 2. Overapplied overhead = $56,000
6-21 1. Total OH assigned: Model X = $171,000, Model Y = $129,000
2. Total OH assigned: Model X = $185,740, Model Y = $114,305
6-22 2. Total OH assigned: Model X = $171,001, Model Y = $129,002
6-24 2. Unit cost (ABC): Standard = $189.50, Deluxe = $571.00
6-27 1. Gross margin: Part 127 = $10.50, Part 234 = $11.97
2. Gross margin (loss): Part 127 = $16.60, Part 234 = $(18.54)
6-28 3. Unused capacity cost = $92,000
6-29 2. Overhead per unit: Cylinder A = $1,467, Cylinder B = $600
4. Overhead per unit: Cylinder A = $1,467, Cylinder B = $600
5. Overhead per unit: Cylinder A = $1,467, Cylinder B = $600
6-30 1. Percentage of total activity costs = 85%
2. Overhead per unit: Cylinder A = $1,004.38, Cylinder B = $832.01
6-31 3. Overhead per unit: Scientific = $5.95, Business = $1.61

Chapter 7

7-15 2. Total cost = $1.18
7-16 2. Total = $431.67
7-19 1. Total cost: Department A = $55,000, Department B = $55,000
7-20 2. Toothpaste = $56.01 per MHr, Tooth Whitener = $23.27 per MHr
7-21 2. Toothpaste = $52.60 per MHr, Tooth Whitener = $24.41 per MHr
7-22 2. Assembly = $14.00 per DLHr, Finishing = $8.18 per DLHr
7-23 2. Assembly = $13.70 per DLHr, Finishing = $8.36 per DLHr
7-24 2. Assembly = $14.09 per DLHr, Finishing = $8.12 per DLHr
7-27 2. Incremental value of further processing = $10,000
7-34 2. In-house members: Total = $233,584, Out-of-house members: Total = $41,293

Chapter 8

8-18 Total = $11,605,000
8-22 1. Ending cash balance = $2,783

8-23 Total cash receipts: August = $46,623, September = $58,105
8-24 1. Total: August = $22,350, September = $27,814
2. Total: July = $23,683, August = $25,644
8-25 1. Total overhead costs = $188,100
8-28 1. Total = $ 3,026,000
8-29 7. Total unit cost = $76.96
8. Budgeted cost of goods sold = $4,155,302
9. Income before income taxes = $42,298
8-31 1. Total predicted overhead = $423,145
2. Total predicted overhead = $423,201
8-32 1. Total predicted overhead = $423,184
2. Total predicted overhead = $423,109

Chapter 9

9-12 1. *SQ* = 1,456,000 kilograms
2. *SH* = 210,000 hours
9-13 1. *MPV* = $6,240 U, *MUV* = $1,040 U
2. *LRV* = $0, *LEV* = $900 U
9-16 1. Yield ratio = 0.90
2. *SPy* = $450.01
4. Direct material mix variance = $39,973.65 U
9-18 1. Yield ratio = 5
2. Standard cost = $3.04 per unit of yield
9-19 1. *MPV* = $2,714 F, *MUV* = $280 U
2. *LRV* = $9,100 U, *LEV* = $12,000 U
9-22 1. Direct materials = $24,480, Direct labour = $81,600
3. *MPV* = $1,075 F, *MUV* = $1,320 U
4. *LRV* = $1,712.50 U, *LEV* = $600 U
9-23 1. Standard variable overhead rate = $2.22 per DLHr
2. Total variable overhead variance = $4,920 U
9-24 1. *MPV* = $27,400 F, *MUV* = $13,780 U
2. *LRV* = $2,005 F, *LEV* = $6,300 U
9-26 1. *MPV* = $5,416 F, *MUV* = $6,480 U
2. *LRV* = $730 F, *LEV* = $8,100 U
9-27 2. *MPV* = $2,800 F, *MUV* (Regular) = $1,200 F
3. *LRV* = $3,700 F, *LEV* (Regular) = $5,600 U
9-28 1. Yield variance = $42,750 F
9-29 1. Yield variance = $21,000 F
9-30 4. *LEV* = $7,600 F
9-32 2. Cost of goods transferred out = $1,995,000

Chapter 10

10-9 1. KiddieKamp residual income = $200
10-10 1. EVA = $(34,000)
10-12 1. Increased profit = $182,000
10-13 2. Transfer price = $241.20
10-14 1. Transfer price = $4.22
2. Transfer price = $3.92
10-15 2. Transfer price = $7.30
10-16 1. South American = $7,500
2. South American = 0.19%
3. South American = 10.19%
10-17 2. D's residual income = $336
10-18 1. Residual income = $51,000
2. ROI = 18.40%
10-19 1. Value of option = $230,000
10-21 5. Contribution margin = $73,500
10-23 3. Total addition to profits = $768,000

Chapter 11

11-8 1. Incremental loss per golf kit = $(1.55)
11-9 2. Maximum price = $68.92
11-11 1. Loss from accepting order = $(10,955)
3. Loss from accepting order = $(3,680)
11-12 1. Operating income = $367,800
2. Operating income = $367,800
11-13 1. Gross profit = $46,000
11-14 2. Total tariff-related savings = $96,720
11-15 1. Total annual cost = $3,050
11-17 1. Operating income = $18,280
2. Operating income = $49,889
11-19 2. Operating income = $1,749,000
11-20 2. Activity rate per procedure = $176
11-24 1. Total relevant costs: Lease and make = $51,000, Buy = $50,000
2. Total relevant cost: Make = $58,600, Buy = $50,000

Chapter 12

12-13 1. Markup percentage = 16%
2. Bid = $539,400
12-15 2. Operating income = $145,900
3. Operating income = $133,750
12-16 2. Operating income = $31,890
12-18 1. Sales price variance = $1,050 F
2. Price volume variance = $715 F
12-19 1. Product P: Price volume variance = $800,000 F
12-21 1. Total cost = $1,476,000
2. Total cost = $1,008,000
12-22 3. (a) Operating income = $214,400
12-23 1. Cost of goods sold: Year 1 = $412,500, Year 2 = $510,000
2. Cost of goods sold: Year 1 = $337,500, Year 2 = $405,000
12-24 1. Contribution margin variance = $17,300 F
3. Sales mix variance = $300 F
12-25 1. Contribution margin variance = $3,490 F
12-26 1. Net change in income = $(600)
12-28 1. Operating income (loss) = $(238.45)
2. Operating income = $785
12-29 1. Operating income = $2,455,000
12-30 1. Operating income = $(75,000)
12-31 1. Profit on first year = $675
12-32 1. Operating income = $296,400
12-33 1. Operating income = $72,250

Chapter 13

13-10 1. Unit cost: Wood = $200.05, Gardner = $208.24
13-11 1. Customer profitability = $5,474,000
13-19 1. Cost per unit of average product = $62.50
2. Cost per unit of average product = $63
13-20 1. Unit cost: Bach = $404.60, Rivera = $310.98
13-22 1. Total savings = $2,675,000
13-23 4. Income before taxes = $191,250
13-24 1. Target cost = $115 per unit
3. Design A: Profit per unit = $15.43
4. Increase in benefits = $800,000
13-26 1. After JIT unit cost = $32.54

Chapter 14

14-20 1. Total: Fixed = $1,221,000, Variable = $1.38
4. Total: Fixed = $441,000, Variable = $1.38

14-21 2. Total = $852,000
3. Cost reduction to maintain = $6, Cost reduction to expand = $8
4. Unit savings = $8.35

14-22 2. Moulding: *SQ* = 2,538,000 kg, Engineering: *SQ* = 126,720 eng. hrs

14-23 1. Target cost = $1,224
2. Unit non-value-added cost = $414

Chapter 15

15-7 1. Theoretical conversion cost per unit = $324
2. Applied conversion cost per unit = $540

15-8 1. Cycle time (actual) = 40 minutes per laptop
2. Assignment per unit (actual) = $120

15-16 1. (d) 2011: 16%, 2013: 18%
(g) 2011: 6.25%, 2013: 2.22%
(k) 2011: 2,600, 2013: 13,000

15-19 1. Cycle time (theoretical) = 20 minutes per unit
2. Assignment per unit (theoretically) = $10.00
4. Cost = $7.50

15-20 1. MCE = 0.30

15-21 1. Theoretical cycle time = 80 minutes per model
2. Actual cycle time = 96 minutes per model

Chapter 16

16-9 2. Hidden cost = $225,000

16-12 1. Total quality costs = $1,350,000

16-13 2. Profit potential = $900,000

16-15 2. (c) Bonus pool = $73,600

16-21 1. Total environmental costs = $9,855,000

16-23 1. Unit cost per kilogram: Org AB = $0.542, Org XY = $0.0912

16-24 1. Treatment rate = $0.10 per kilogram

16-25 1. Total quality costs = $8,000,000

16-29 1. Total quality costs = $1,396,500

16-30 1. Total quality costs: January = $86,000, February = $100,500

16-31 1. External failure costs: 2012 = 33.2%, 2013 = 36.1%

16-38 1. Total benefits = $1,131,000, Total costs = $1,179,000

Chapter 17

17-6 1. Total time = 400 minutes
3. Time saved = 19.83 minutes per bottle (21.33 for continuous)

17-9 1. Unit cost: Model A = $159, Model B = $160.33

17-10 2. Week 3: Average cost = $22.22

17-13 1. Value of productivity = $336,000

17-15 2. Price recovery = $857,400

17-16 2. Change in income = $300,000
4. Price-recovery component = $(420,000)

17-17 2. Average lunch cost = $8.50
3. Group A: Average lunch cost = $6.80

17-18 1. Group A: Average lunch cost = $6.17

17-21 1. Current system labour = 0.50

17-22 2. Increase in profits due to productivity = $56,000

17-23 3. Change I = $0, Change II = $495,000

Chapter 18 (www.hansen1ce.nelson.com)

18-5 1. Annual ordering cost = $2,400
3. Cost of current inventory policy = $17,400

18-6 1. *EOQ* = 1,600
2. Total cost = $12,000

18-7 1. *EOQ* = 2,500
2. Ordering cost = $562.50

18-8 1. Reorder point = 840 units

18-9 1. *EOQ* = 60,000
2. Total cost = $180,000

18-10 1. *EOQ* = 20,000
2. Total cost = $180,000

18-11 1. *ROP* (small casings) = 26,400

18-12 Safety stock = 150

18-15 2. Total contribution margin = $7,560,000

18-17 1. *EOQ* = 12,000

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