COST MANAGEMENT: ACCOUNTING AND CONTROL

Delta Publishing Company

DELTA PUBLISHING COMPANY

P.O. Box 5332, Los Alamitos, CA 90721-5332

PREFACE

Cost Management: Accounting and Control is designed for accounting and business managers. It covers the managerial use of accounting, financial, and operating data for planning, control, and decision making. A heavy emphasis is placed on how to manage costs to be globally competitive.

Due to the nature of the subject, the course uses the *multidisciplinary* approach to the subject, looking at the topic from many different angles such as finance, economics, marketing, information systems, quantitative methods, and the like. Heavily emphasized is the incorporation of information technology (i.e., how to use computer software) into virtually every subject covered in this course.

Furthermore, the course uses the *solved problems* approach, with emphasis on the practical application of managerial and cost accounting concepts, tools, and methodology. The reader is provided with the following:

1. Definitions and explanations that are understandable.
2. A variety of examples illustrating the concepts and techniques that are concise.
3. Ample problems and detailed suggested solutions.
4. Computer software demonstration and printouts.
5. Additional materials that supplement the topic.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION TO COST MANAGEMENT

How do American firms fare in the world market? Do American firms really measure the costs of products and services they offer *accurately*? Only recently has this question been seriously addressed. American managers are waking up to find themselves operating in a highly competitive global economy. Manufacturing and service industries are seeing their profits squeezed by the pinch of foreign price and quality competition.

Firms who do know how to accurately measure product costs will find the going tough, while firms who fail to recognize and solve cost measurement problems and to analyze cost data are probably destined for extinction.

Today's cost accountants and managerial accountants have the tremendous responsibility for this task. They are the ones that ensure that the cost accounting systems of their own produce accurate (not distorted) cost data for managerial uses for performance measurement and for strategic decisions on pricing, product mix, process technology, and product design. They are the ones who must know how to analyze cost information for planning and control and make operational and tactical decisions.

After studying the material in this chapter, you will be able to

- State the nature and scope of cost accounting and cost management.
- Distinguish between cost accounting and its related fields such as managerial accounting and financial accounting.
- Describe the three broad purposes for which the manager needs cost information.
- Identify the role of the controller, the treasurer, and the Chief Financial Officer (CFO).
- Summarize the role of the Cost Accounting Standards Board (CASB).
- Identify some new developments that took place in the cost accounting and cost management discipline over the last two decades.
- State four popular certificates that recognize the expertise in the fields of cost/managerial accounting and internal auditing—the **Certified Managerial Accountant (CMA)**, the **Certified in Financial Management (CFM)**, **the Certified Internal Auditor (CIA),** and the **Certified Cost Estimator/Analyst (CCEA)**.

NATURE AND SCOPE OF COST ACCOUNTING AND COST MANAGEMENT

Cost accounting can be defined within the accounting system as internal reporting for use in management planning, control, and in making routine and nonroutine decisions, and external reporting to the extent that its product-costing function satisfies external reporting requirements for reporting to shareholders, government, creditors, investors and various outside interested parties.

In that sense, cost accounting is a *combination* of managerial accounting and financial accounting, which will be discussed later.

Cost is the measurement of the sacrifice of economic resources, which has already been made or is to be made in the future, in order to achieve a specific objective. *Cost management* deals with estimated future or planned costs as well as with past, historical costs. It consists of the following basic activities, whether it is for a manufacturing or service business or for a profit or nonprofit organization:

1. *Cost recording and reporting*, including classifying, summarizing, communicating, and interpreting cost data to interested parties, internal or external.

2. *Cost measurement or estimation* for specific products, services, or subunits of the organization.

3. *Cost planning* It involves selecting the goals of the organization and its subunits, expressed as operating objectives, and then identifying the means of accomplishing them. Plans are summarized in budgets which are expressed in terms of money measurements. For example, a cost budget should be prepared so as to plan for expected expenditures. The profit budget outlines the planned revenues and expenses of the coming time period. The production and cost of goods manufactured budget shows planned inventory levels, units of product which the company plans to make, and the costs of the various types of inputs which will be needed in carrying out the production plans. A budget also achieves control through the comparison of actual and budgeted costs resulting variance determination and analysis.

4. *Cost control* It sets predetermined standards (such as standard costs and budgets) by which performance can be measured. It then reports differences between planned and actual performances to direct attention to what went wrong. Furthermore, cost control aids in fixing responsibility for departures from a plan so that corrective actions can be taken. For example, a cost accounting report to a production department manager may show that the cost of manufacturing one unit of output is significantly higher than the standard cost. Investigation may reveal that the higher cost is due to the inefficient labor, excessive spoilage of materials, or use of faulty equipment and improper production methods.

5. *Cost analysis*, obtaining accurate product-costing data and managing it to assist managers in making critical decisions such as pricing, product mix, and process technology decisions and analyzing cost data, translating them into the information

useful for managerial planning and control, and for making short-term and long-term decisions. This phase involves measurement of accurate and relevant cost data and analyzing them for decision making. *Activity-base costing (ABC)* and *Activity-base Management (ABM)* are two new developments that enhance product costing accuracy. Decision making, which can be described as problem solving, is largely a matter of choosing among alternative courses of action. The questions that arise from time to time are many and varied. Should the new product be introduced? Should one of the products or services in a line be dropped? Should a special order be accepted at below the normal selling price? Should parts now being manufactured be purchased? Should the present equipment be replaced? Should equipment be purchased or leased? Should production capacity be expended? A cost management system is used to support management's needs for better decisions about product design, pricing, marketing, and mix, and to encourage continual operating improvements. Quantitative methods may be used in various phases of cost analysis to determine costs and their financial effects, correlations, and the financial feasibility of adopting alternatives.

FINANCIAL ACCOUNTING VERSUS MANAGEMENT ACCOUNTING

Financial accounting is mainly concerned with the historical aspects of external reporting; that is, providing financial information to outside parties such as investors, creditors, and governments. To protect those outside parties from being misled, financial accounting is governed by what are called *generally accepted accounting principles (GAAP)*.

Management accounting, on the other hand, is concerned primarily with providing information to internal managers who are charged with planning and controlling the operations of the firm and making a variety of management decisions. Due to its internal use within a company, management accounting is not subject to **generally accepted accounting principles (GAAP)**. As defined by the *Financial Accounting Standards Board* (FASB*),* GAAP is the conventions, rules, and procedures necessary to defined accounting practice for external reporting at a particular time.

The differences between financial and management accounting are summarized below:

Financial Accounting	***Management Accounting***
(1) External users of financial information	(1) Internal users of financial information
(2) Must comply with GAAP	(2) Need not comply with GAAP
(3) Must generate accurate and timely data	(3) Emphasizes relevance and flexibility of data
(4) Past orientation	(4) Future orientation
(5) Financial information	(5) Nonfinancial (e.g., speed of delivery, customer complaints) as well as financial information
(6) Looks at the business as a whole	(6) Focuses on parts as well as on the whole of a business
(7) Summary reports	(7) Detailed reports by products, departments, or other segments

(8) Primarily stands by itself	(8) Draws heavily from other disciplines such as finance, economics, information systems, marketing, operations/production management, and quantitative methods

COST ACCOUNTING VERSUS MANAGEMENT ACCOUNTING

The difference between cost accounting and management accounting is a subtle one. The Institute of Management Accountants (IMA) defines cost accounting as "a systematic set of procedures for recording and reporting measurements of the cost of manufacturing goods and performing services in the aggregate and in detail. It includes methods for recognizing, classifying, allocating, aggregating and reporting such costs and comparing them with standard costs."

Management accounting as defined by the IMA is the process of identification, measurement, accumulation, analysis, preparation, interpretation, and communication of financial information, which is used by management to plan, evaluate, and control within an organization. It ensures the appropriate use of and accountability for an organization's resources. Management accounting also relates to the preparation of financial reports for nonmanagement groups such as regulatory agencies and tax authorities. Simply stated, management accounting is the accounting used for the planning, control, and decision-making activities of an organization.

From this definition of cost accounting and the IMA's definition of management accounting, one thing is clear: the major function of cost accounting is cost accumulation for inventory valuation and income determination. Management accounting, however, emphasizes the use of the financial and cost data for planning, control, and decision-making purposes.

EXAMPLE

Management accounting typically does not deal with the details of how costs are accumulated and how unit costs are computed for inventory valuation and income determination. Although unit cost data are used for pricing and other managerial decisions, the method of computation itself is not a major topic of management accounting but rather for cost accounting.

THE WORK OF MANAGEMENT

In general, the work that management performs (the management process) can be classified as (a) planning, (b) controlling, and (c) decision making.

Planning: The planning function of management involves selecting long- and short-term objectives and drawing up strategic plans to achieve those objectives. *Coordinating:* In performing the coordination function, management must decide how best to put together the firm's resources in order to carry out established plans.

Controlling: Controlling entails implementing a decision method and using feedback so that the firm's goals and specific strategic plans are optimally obtained.

Decision making: Decision making is the purposeful selection from a set of alternatives in light of a given objective.

Management accounting information is important in performing all of these functions.

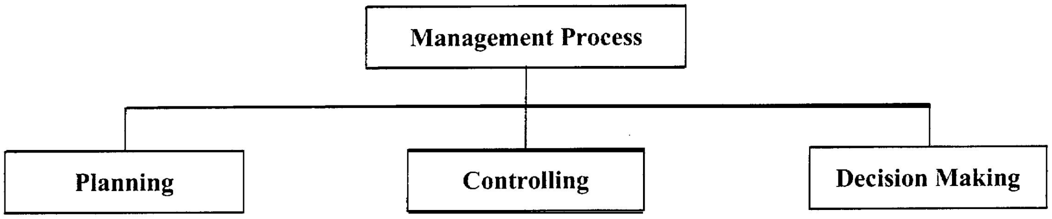
The management process is summarized in Figure 1.

THE ORGANIZATIONAL ASPECT OF MANAGEMENT FUNCTION

There are two types of authorities in the organizational structure: line and staff. *Line authority* is the authority to give orders to subordinates. Line managers are responsible for attaining the goals set by the organization as efficiently and profitably as possible. Production and sales managers typically possess line authority.

Staff authority is the authority to give advice, support, and service to the line departments. Staff managers do not command others. Examples of staff authority are found in personnel, purchasing, engineering, and finance. The management accounting function is usually a staff function with the responsibility for providing line managers and also other staff people with a specialized service. The service includes (a) budgeting, (b) controlling, (c) pricing, and (d) special decisions.

FIGURE 1
MANAGEMENT PROCESS



Planning

- Setting objectives
- Identifying ways to achieve the objectives
- Example: budgets

Controlling

- Monitoring a plan's implementation
- **Feedback** is information used to evaluate or correct implementation of a plan.
- Based on feedback, a manager might:
  - continue the implementation as originally planned
  - take corrective action if needed, or
  - modify the plan.
- Example: **performance reports**, which are accounting reports that provide feedback by comparing actual results with plans

Decision Making

- Choosing among competing alternatives
- Example: deciding the selling price of products

CONTROLLERSHIP

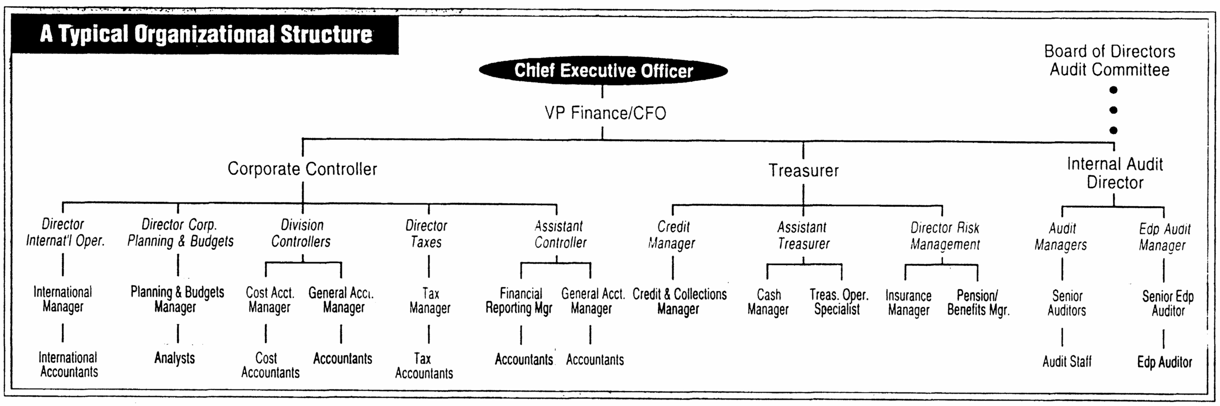
In a large firm, the financial responsibilities are carried out by the treasurer, controller, and financial vice president, often called a *chief financial officer (CFO).* Figure 2 shows an organization chart of the finance structure within a company. Note that the controller and treasurer report to the vice president of finance. The treasurer is responsible for managing corporate assets and liabilities, planning the finances, budgeting capital, financing the business, formulating credit policy, and managing the investment portfolio.

The chief management accountant or the chief accounting executive of an organization is called the *controller* (often called *comptroller*, especially in the government sector). The controller is in charge of the accounting department. The controller's authority is basically staff authority in that the controller's office gives advice and service to other departments. But at the same time, the controller has line authority over members of his or her department such as internal auditors, bookkeepers, budget analysts, etc. (See Figure 3 for an organization chart of a controllership situation).

The controller is basically concerned with *internal* matters, namely, financial and cost accounting, taxes, budgeting, and control functions. The financial vice president is involved with financial policymaking and planning. He or she supervises all phases of financial activity and serves as the financial advisor to the board of directors.

The effective, competent, and timely handling of controllership and treasury functions will ensure corporate financial success. The Financial Executive Institute, an association of corporate controllers and treasurers, distinguishes their functions as shown in Table 1.

FIGURE 2



A Typical Organizational Structure
Chief Executive Officer
Board of Directors Audit Committee
VP Finance/CFO
Corporate Controller
Treasurer
Internal Audit Director
Director Internat'l Oper.
Director Corp. Planning & Budgets
Division Controllers
Director Taxes
Assistant Controller
Credit Manager
Assistant Treasurer
Director Risk Management
Audit Managers
Edp Audit Manager
International Manager
Planning & Budgets Manager
Cost Acct. Manager
General Acct. Manager
Tax Manager
Financial Reporting Mgr
General Acct. Manager
Credit & Collections Manager
Cash Manager
Treas. Oper. Specialist
Insurance Manager
Pension/ Benefits Mgr.
Senior Auditors
Senior Edp Auditor
International Accountants
Analysts
Cost Accountants
Accountants
Tax Accountants
Accountants
Accountants
Audit Staff
Edp Auditor

FIGURE 3

CONTROLLERSHIP

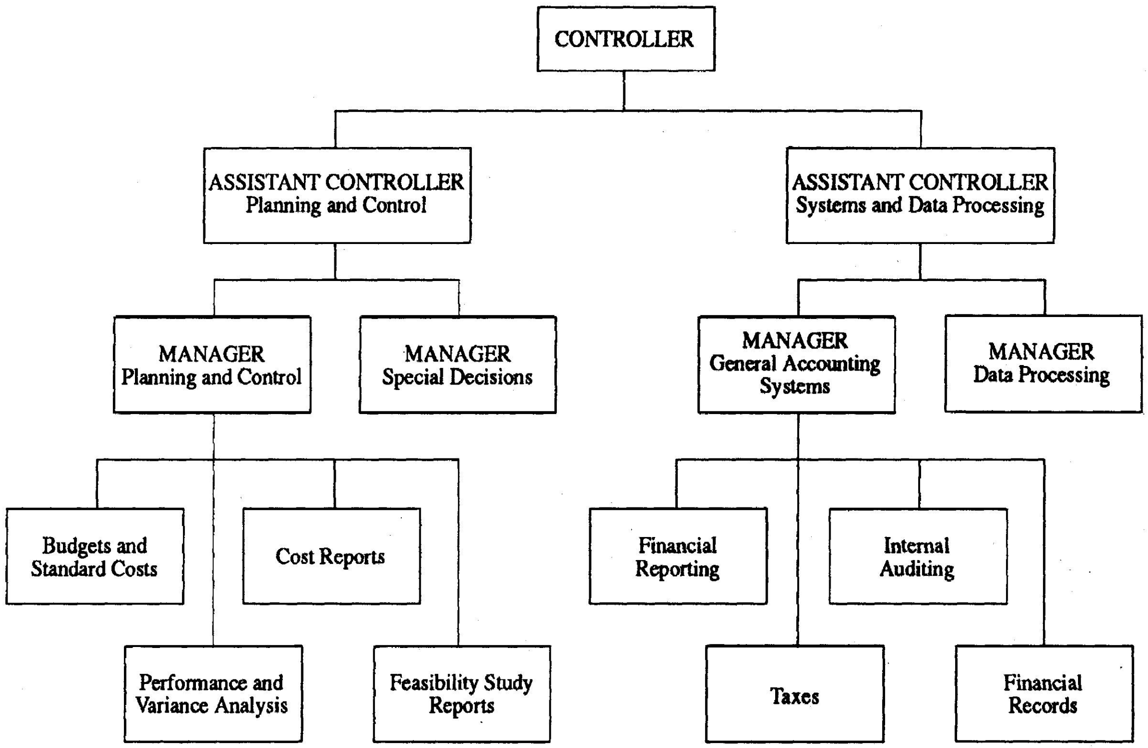


TABLE 1

FUNCTIONS OF CONTROLLER AND TREASURER

Controller	Treasurer
Accounting	Obtaining Financing
Reporting of financial information	Banking relationship
Custody of records	Investment of funds
Interpretation of financial data	Investor relations
Budgeting	Cash management
Controlling operations	Insuring assets
Appraisal of results and making recommendations	Fostering relationship with creditors and investors
Preparation of taxes	Credit appraisal and collecting funds
Managing assets	
Internal auditing	Deciding on the financing mix
Protection of assets	Dividend disbursement
Reporting to the government	Pension management
Payroll	

It is important to note that there is no universally accepted, precise distinction between the two jobs and the functions may differ slightly between organizations because of size, personality and company policy.

COST ACCOUNTING STANDARDS BOARD

The Cost Accounting Standard Board (CASB), an agency of the US Congress, was established in 1970 to promulgate cost accounting standards covering negotiated defense contracts. "Negotiated" means that the price is tied to costs rather than to competitive bidding. The creation of the CASB was a response to complaints about inconsistent accounting practices of companies that had cost-plus contracts with the government. Many state governments also require adherence to CASB standards in cost-plus contract situations.

The standards are mainly concerned with definitions, uniformity, and consistency in cost accounting practices. The standards begin with Number 400. Until the CASB's activities ceased in 1980, the Board had issued 19 standards. In 1988, Congress reestablished the CASB as an independent body in the Office of Federal Procurement Policy. It has "exclusive authority to make, promulgate, amend, and rescind cost accounting standards and interpretations thereof" for negotiated contracts and subcontracts over $500,000. CASB standards are incorporated into Federal Acquisition Regulations (FARs).

The Government Accounting Office (GAO) is now responsible for interpreting CASB standards. A list of CASB standards is presented below.

The standards are classified into the following three categories:

1. Standards addressing overall cost accounting matters

400 Definitions
401 Cost accounting standard--consistency in estimating, accumulating, and reporting costs
402 Cost accounting standard--consistency in allocating costs incurred for the same purpose
405 Accounting for unallowable costs
406 Cost accounting standard--cost accounting period

2. Standards addressing classes, categories, or elements of cost

404 Capitalization of tangible assets
407 Use of standard costs for direct material and direct labor
408 Accounting for costs of compensated personal absence
409 Depreciation of tangible capital assets
411 Accounting for acquisition costs of material
412 Composition and measurement of pension cost
413 Adjustment and allocation of pension cost
414 Cost of money as an element of the cost of facilities capital
415 Accounting for the cost of deferred compensation
416 Accounting for insurance costs
417 Cost of money as an element of the cost of capital assets under construction

3. Standards addressing allocation of costs

403 Allocation of home office expenses to segments
410 Allocation of business unit general and administrative expenses to final objectives
418 Allocation of direct and indirect costs
(Proposed Standard 419 was combined with this standard)
420 Accounting for independent research and development and bid and proposal costs

Note: The standards established by the CASB are not necessarily acceptable for financial statement reporting purposes. They are required only for price-setting.

Copies of CASB standards, rules, and regulations are available from the:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C., 20402

COST MANAGEMENT IN THE NEW PRODUCTION ENVIRONMENT

Over the past two decades, new technologies and management philosophies have changed the face of cost/managerial accounting. Following are the key developments that have reshaped the discipline. We will discuss these at length in future chapters. For example, where automation and computer-assisted manufacturing methods have replaced the workforce, labor costs have shrunk from between 30 and 50 percent of product and service costs to around 5 percent. Cost accounting in traditional settings required more work to keep track of labor costs than do present systems. On the other hand, in highly automated environments, cost accountants have had to become more sophisticated in finding causes of costs because labor no longer drives many cost transactions.

Total Quality Management and Quality Costs

In order to be globally competitive in today's world-class manufacturing environment, firms place an increased emphasis on quality and productivity. Total quality management (TQM) is an effort in this direction. Simply put, it is a system for creating competitive advantage by focusing the organization on what is important to the customer.

Total quality management can be broken down into: *Total*: that is the whole organization is involved and understands that customer satisfaction is everyone's job. *Quality:* the extent to which products and services satisfy the requirements of internal and external customers. *Management*: the leadership, infrastructure and resources that support employees as they meet the needs of those customers. Market shares of many U.S. firms have eroded because foreign firms have been able to sell higher-quality products at lower prices. Under TQM, performance measures are likely to include product reliability and service delivery, as well as such traditional measures as profitability.

In order to be competitive, U.S. firms have placed an increased emphasis on quality and productivity in order to:

1. Produce savings such as reducing rework costs, and
2. Improve product quality.

Quality costs are classified into three broad categories: prevention, appraisal, and failure costs. Quality cost reports can be used to point out the strengths and weaknesses of a quality system. Improvement teams can use them to describe the monetary benefits and ramifications of proposed changes. Chapter 15 focuses on total quality management and quality costs.

Continuous Improvement (CI) and Benchmarking

Continuous improvement (CI), based on a Japanese concept called *Kaizen*, is a management philosophy that seeks endless pursuit of improvement of machinery, materials, labor utilization, and production methods through application of suggestions and ideas of team members. The CI utilizes many different approaches, including: *statistical process control (SPC)* using traditional statistical control charts and *benchmarking* examining excellent performers outside the industry and seeing how you can use their best practices. Benchmarking typically involve the following steps:

1. Identify those practices needing improvement.
2. Identify a company that is the world leader in performing the process.
3. Interview the managers of the company and analyze data obtained.

Continuous improvement and benchmarking is often called "the race with no finish" because managers and employees are not satisfied with a particular performance level but seek ongoing improvement.

Business Process Reengineering (BPR)

TQM seeks evolutionary changes in the processes while the practice called *business process reengineering (BPR)* seeks to make revolutionary changes. BPR does this by taking a fresh look at what the firm is trying to do in all its processes, and then eliminating nonvalue-added steps and streamlining the remaining ones to achieve the desired outcome.

Just-in-Time and Lean Production

The inventory control problem occurs in almost every type of organization. It exists whenever products are held to meet some expected future demand. In most industries, cost of inventory represents the largest liquid asset under the control of management. Therefore, it is very important to develop a production and inventory planning system that will minimize both purchasing and carrying costs. Material cost, as a proportion of total product cost, has continued to rise significantly during the last few years and hence, is a primary concern of top management.

Just-in-Time (JIT) is a demand-pull system. Demand for customer output (not plans for using input resources) triggers production. Production activities are "pulled", not "pushed," into action. JIT production, in its purest sense, is buying and producing in very small quantities just in time for use. JIT production is part of a "lean production" philosophy that has been credited for the success of' many Japanese companies. Lean production eliminates inventory between production departments, making the quality and efficiency or production the highest priority. Lean production requires the flexibility to change quickly from one product to another. It emphasizes employee training and participation in decision-making. The development of just-in-time production and purchasing methods also affects cost-accounting systems. Firms using just-in-time methods keep inventories to a minimum. If inventories are low, accountants can spend less time on inventory valuation for external reporting. Chapter 16 covers the JIT inventory system.

Theory of Constraints (TOC) and Bottlenecks Management

The theory of constraints (TOC) views a business as a linked sequence of processes that transforms inputs into salable outputs, like a chain. To improve the strength of the chain, a TOC company identifies the weakest link, which is the constraint. TOC exploits constraints so that throughput is maximized and inventories and operating costs are minimized. It then develops a specific approach to manage constraints to support the objective of *continuous improvement.*

Bottlenecks occur whenever demand (at least temporarily) exceeds capacity. For example, although a legal secretary has enough total time to do all her wordprocessing, she may be given several jobs in quick succession, so that a queue (waiting line) builds up. This is a bottleneck, which delays the other activities waiting for the wordprocessing to be finished. TOC seeks to maximize “throughput” by

1. Larger lot sizes at bottleneck work stations, to avoid time lost on changeovers;
2. Small transfer batches—forwarding a small batch of work to the next work station, so that the next operation can begin before the entire lot is finished at the preceding work station; and
3. Rules for inserting buffer stock before or after certain bottlenecks.

Corporate Balanced Scorecard

A problem with just assessing performance with financial measures like profit, ROI and Economic Value Added (EVA) is that the financial measures are "backward looking.'" In other words, today's financial measures tell you about the accomplishments and failures of the past. An approach to performance measurement that also focuses on what managers are doing today to create future shareholder value is the Balanced Scorecard. The Balanced Scorecard is a set of performance measures constructed for four dimensions of performance--financial, customer, internal processes, and learning and growth.

Life-Cycle Costs and Target Costing

Life-cycle costing tracks and accumulates all product costs in the value chain from research and development and design of products and processes through production, marketing, distribution, and customer service. The value chain is the set of activities required to design, develop, produce, market, and service a product (or service). The terms “cradle-to-grave costing” and “womb-to-tomb costing” conveys the sense of fully capturing all costs associated with the product. Life-cycle cost concepts are associated with target costing and target pricing. A firm may determine that market conditions require that a product sell at a given target price. Hence, target cost can be determined by subtracting the desired unit profit margin from the target price. The cost reduction objectives of life-cycle cost management can therefore be determined using target costing.

Six-Sigma

An approach to reducing costs related to business processes is Six-Sigma. Six Sigma is a structured and disciplined, data-driven process for improving business performance. The Six Sigma methodology concentrates on reducing variability in processes. . Sigma is a statistical term that measures how far a given process deviates from customer requirements and a measure of process capability. The term "Six Sigma" refers to the ability of highly capable processes to produce output within specification.

THE CERTIFIED MANAGEMENT ACCOUNTANT (CMA)

Management accounting has expanded in scope to cover a wide variety of business disciplines such as finance, economics, organizational behavior, and quantitative methods. In line with this development, the Institute of Management Accountants (IMA) created the Institute of Certified Management Accountants, which offers a program leading to the *Certified Management Accountant (CMA)* examination.

The objectives of the CMA program are fourfold: (1) to establish management accounting as a recognized profession by identifying the role of the management accountant and financial manager, the underlying body of knowledge, and a course of study by which such knowledge is acquired; (2) to encourage higher educational standards in the management accounting field; (3) to establish an objective measure of an individual's knowledge and competence in the field of management accounting; and (4) to encourage continued professional development by management accountants.

The CMA program requires candidates to pass a series of uniform examinations covering a wide range of subjects. The examination consists of the following four parts:

Part 1: Business Analysis (3 hours – 110 multiple-choice questions)
Part 2: Management Accounting and Reporting (4 hours – 140 multiple-choice questions)
Part 3: Strategic Management (3 hours – 110 multiple-choice questions)
Part 4: Business Applications (3 hours – 4 to 7 essays/problems – Available February, May, August, November)

Note:

1. For more information, call IMA at (800) 638-4427, ext. 265 or (201) 573-6300 or visit their Web site: **www.imanet.org.**

2. The IMA publishes two important journals: *Management Accounting* (quarterly) and *Strategic Finance* (monthly).

3. Gleim Publications, Inc. (**www.gleim.com,** 800-874-5346) offers CMA/CFM Review books, test prep software, review audio tapes, and other cost/managerial accounting study materials.

THE CERTIFIED INTERNAL AUDITOR (CIA)

This certification was created in 1974 by the Institute of Internal auditors (IIA). The CIA exam is also broader than the CPA exam because it covers a broad range of areas, among them management, economics, finance, and quantitative methods. The CIA exam lasts 14 hours (four 3 1/2-hour parts) and covers the following areas:

Part 1 - The Internal Audit Activity's Role in Governance, Risk, and Control
Part 2 - Conducting the Internal Audit Engagement
Part 3 - Business Analysis and Information Technology
Part 4 - Business Management Skills

Note:

1. For more information, call IIA at (407) 830-7600, visit their Web site: **www.theiia.org,** or write to:

   Institute of Internal auditors (IIA)
   249 Maitland Avenue
   Altamonte Springs, FL 32701

2. The exam is given in the 2nd week after CPA (Wed, Thur).

3. Gleim Publications, Inc. (**www.gleim.com,** 800-874-5346) offers CIA Review books, test prep software, review audio tapes, and other related study materials.

SOCIETY OF COST ESTIMATING AND ANALYSIS (SCEA) CERTIFICATION

The Society of Cost Estimating and Analysis (SCEA) (**www.sceaonline.net/**) administers a professional certification program to award the designation of *Certified Cost Estimator/Analyst (CCEA)* to qualified applicants. The award of the CCEA designation is based on the applicants meeting criteria of education and/or job experience in the area of cost analysis and satisfactorily passing a written examination conducted by the Society. The test is a four hour, two part examination intended to allow the candidates the opportunity to demonstrate their knowledge of both general theory and quantitative methods applicable to cost estimating or analysis. According to the SCEA, the body of knowledge of cost analysis includes:

1. Basic skills--background knowledge
2. Cost concepts
3. Cost theory
4. Data and measurement
5. Estimation and testing statistical theory
6. Analysis techniques

Note: For more information, email at **scea@sceaonline.net,** call SCEA at (703) 751-8069, or fax at (703) 461-7328.

CHAPTER SUMMARY

Managerial accounting is the accumulation and analysis of cost data to provide information for external reporting, for internal planning and control of an organization's operations, and for short-term and long-term decisions. This chapter outlined the what and why of management accounting and the relationship between management accounting and its closely related fields--cost accounting and financial accounting.

The chapter also covered the discussion on the role of the controller. Management accounting is expanding rapidly in scope. Also covered was a brief outline of three certification programs that recognize the expertise in the fields of management accounting.

CHAPTER 2
COST CLASSIFICATIONS, TERMINOLOGY, AND PROFIT CONCEPTS

In financial accounting, the term *cost* is defined as a measurement, in monetary terms, of the amount of resources used for some purpose. In managerial accounting, the term *cost* is used in many different ways. That is, there are different types of costs used for different purposes. Some costs are useful and required for inventory valuation and income determination. Some costs are useful for planning, budgeting, and cost control. Still others are useful for making short-term and long-term decisions. A profit concept, *contribution margin,* which is extremely useful to managers, is also introduced.

After studying the material in this chapter, you will be able to

- Identify and cite examples of each of the basic cost elements involved in the manufacture of the product.
- Define various cost concepts.
- Distinguish between variable costs and fixed costs and explain the difference in their behavior.
- Explain the difference between the financial statements of a manufacturer and those of a merchandising firm.
- Differentiate between the traditional income statement and the contribution income statement and their uses.
- Define profit concepts such as *contribution margin*.

COST CLASSIFICATIONS

Costs can be classified into various categories, according to:

1. Their management function
    a. Manufacturing costs
        - Direct materials
        - Direct labor
        - Factory overhead
    b. Nonmanufacturing (operating) costs
        - Selling (marketing) costs
        - General and administrative (G&A) costs

2. Their timing of charges against sales revenue
   a. Product costs
   b. Period costs

3. Their ease of traceability
   a. Direct costs
   b. Indirect costs

4. Their behavior in accordance with changes in activity
   a. Variable costs
   b. Fixed costs
   c. Mixed (semivariable) costs

5. Their degree of averaging
   a. Total costs
   b. Unit (average) costs

6. Their relevance to planning, control and decision making
   a. Sunk costs
   b. Incremental costs
   c. Relevant costs
   d. Out-of-pocket costs
   e. Opportunity costs
   f. Controllable and noncontrollable costs
   g. Standard costs

We will discuss each of the cost categories in the remainder of this chapter.

Costs by Management Function

In a manufacturing firm, costs are divided into two major categories, by the functional activities they are associated with: (1) manufacturing costs and (2) nonmanufacturing costs, also called operating expenses.

MANUFACTURING COSTS. **Manufacturing (production) costs** are those costs associated with the manufacturing activities of the company. Manufacturing costs are subdivided into three categories: direct materials, direct labor, and factory overhead. **Direct materials** (also called *raw materials*) are all materials that become an integral part of the finished product. Examples are the steel used to make an automobile and the wood to make furniture. Glues, nails, and other minor items are called indirect materials (or supplies) and are classified as part of factory overhead, which is explained below.

Direct labor is the labor directly involved in making the product. Examples of direct labor costs are the wages of assembly workers on an assembly line and the wages of machine tool operators in a machine shop. **Indirect labor**, such as wages of supervisory personnel and janitors, is classified as part of factory overhead. **Factory overhead** can be defined as including all costs of manufacturing except direct materials and direct labor. Some of the many examples include depreciation, rent, property taxes, insurance, fringe benefits, payroll taxes, setup costs, waste control costs, quality costs, engineering, workmen's compensation, and cost of idle time. Factory overhead is also called *manufacturing overhead, indirect manufacturing expenses*, *factory expense*, and *factory burden*.

Many costs overlap within their categories. For example, direct materials and direct labor when combined are called **prime costs**. Direct labor and factory overhead when combined are termed **conversion costs** (or processing *costs*).

One important category of factory overhead is that of **quality costs.** Quality costs are costs that occur because poor quality may exist or actually does exist. These costs are significant in amount, often totaling 20 to 25 percent of sales. The subcategories of quality costs are prevention, appraisal, and failure costs. *Prevention costs* are those incurred to prevent defects. Amounts spent on quality training programs, researching customer needs, quality circles, and improved production equipment are considered in prevention costs. Expenditures made for prevention will minimize the costs that will be incurred for appraisal and failure. *Appraisal costs* are costs incurred for monitoring or inspection; these costs compensate for mistakes not eliminated through prevention. *Failure costs* may be internal (such as scrap and rework costs and reinspection) or external (such as product returns or recalls due to quality problems, warranty costs, and lost sales due to poor product performance).

NONMANUFACTURING COSTS. **Nonmanufacturing costs** (also called *nonproduction costs* or *operating expenses*) are subdivided into selling expenses, general and administrative expenses, and research and development costs. **Selling expenses** (also called *marketing costs*) are those associated with obtaining sales and the delivery of the product. Examples are advertising and sales commissions. **General and administrative expenses (G&A)** (or *administrative expenses*, for short) include those incurred to perform general and administrative activities. Examples are executives' salaries and legal expenses. **Research and development costs** include all costs of developing new products and services. Such costs are becoming increasingly critical as more high-technology companies enter the economy and as global competition intensifies. Many other examples of costs by management function and their relationships are found in Figure 1.

Product Costs and Period Costs

By their timing of charges against revenue or by whether they are inventoriable, costs are classified into: (a) product costs and (b) period costs.

Product costs are inventoriable costs, identified as part of inventory on hand. They are treated as an asset until the goods they are assigned to are sold. At that time they become the expense, cost of goods sold. All manufacturing costs are product costs.

Product $\longrightarrow$ Asset $\longrightarrow$ Expense

Costs	(Inventory)	(Cost of Goods Sold)

GAAP and income tax regulations require that firms treat all manufacturing costs as product costs for external financial reporting using full absorption costing (also called absorption costing). Using *full absorption costing*, the firm assigns a unit's variable manufacturing cost plus a share of fixed manufacturing costs to each unit produced. Thus the total of units manufactured "fully absorbs" manufacturing costs. (The variable-fixed classification of costs is explained later).

Period costs are all expired costs that are not necessary for production and hence are charged against sales revenues in the period in which the revenue is earned. Firms treat all nonmanufacturing costs--selling, general and administrative expenses, and research and development costs--as period costs.

Period costs $\longrightarrow$ Expense

Figure 2 shows the relationship of product and period costs and other cost classifications presented thus far.

Direct Costs and Indirect Costs

Costs may be viewed as either direct or indirect in terms of the extent that they are *traceable* to a particular cost object. A **cost object** is any item for which the manager wishes to measure cost. Jobs, product lines, departments, divisions, sales territories, or units produced are typical cost objects. **Direct costs** can be directly traceable to the costing object. For example, if the object of costing under consideration is a product line, then the materials and labor involved in the manufacture of the line would both be direct costs.

Factory overhead items are all indirect costs since they are not directly identifiable to any particular product line. Costs shared by different departments, products, or jobs, called *common costs* or *joint costs*, are also **indirect costs**. National advertising that benefits more than one product and sales territory is an example of an indirect cost. Accountants may *allocate* them on some *arbitrary* basis to specific products or departments.

YOU SHOULD REMEMBER

The following examples illustrate a cost object and its related direct costs for nonmanufacturing firms.

- In a *retail firm*, such as a department store, costs can be traced to a department. For example, the direct costs of the shoe department include the costs of shoes and the wages of employees working in that department. Indirect costs include the costs of utilities, insurance, property taxes, storage, and handling.

- In a *service organization*, such as an accounting firm, costs can be traced to a specific service, such as tax return preparation. Direct costs for tax return preparation services include the costs of tax return forms, computer usage, and labor to prepare the return. Indirect costs include the costs of office rental, utilities, secretarial labor, telephone expenses and depreciation of office furniture.

FIGURE 1
COSTS BY MANAGEMENT FUNCTION

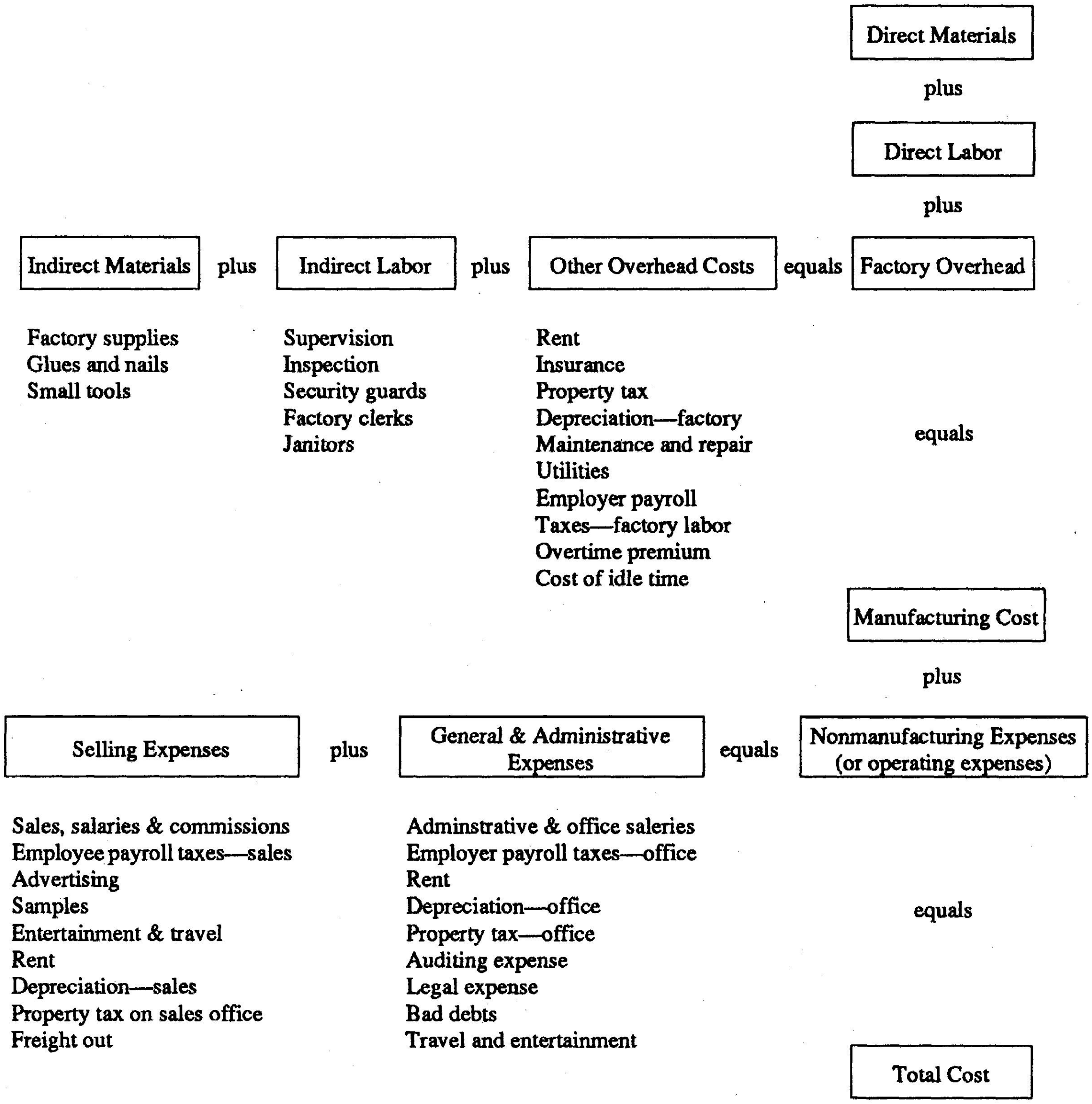
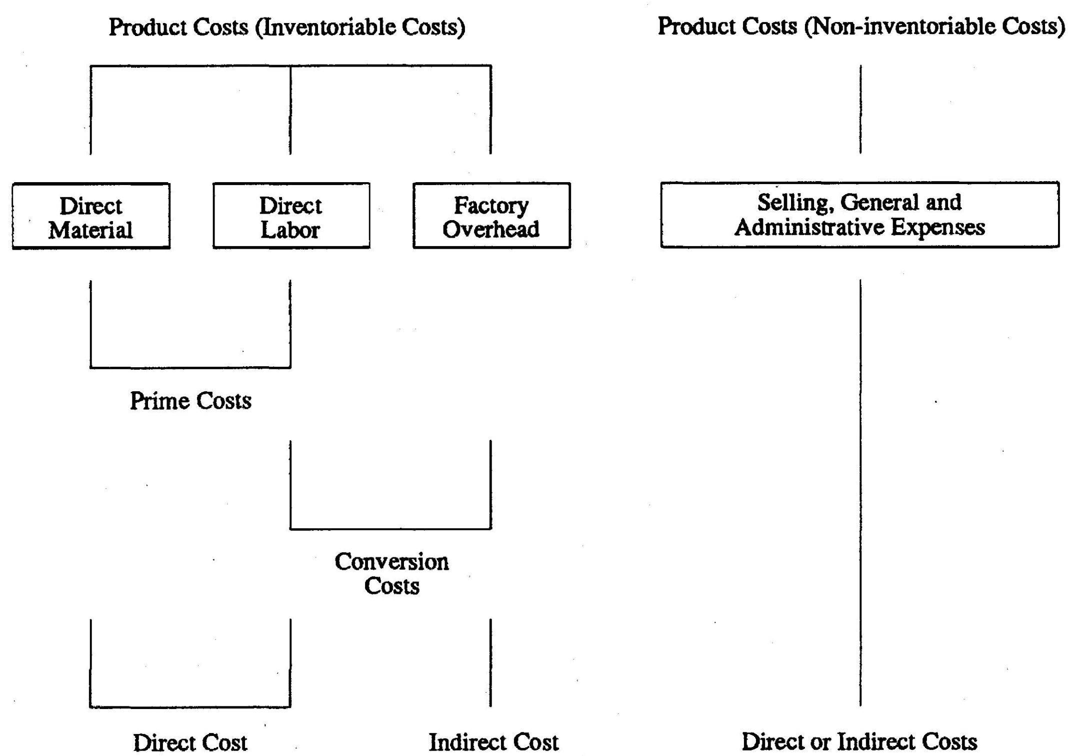


FIGURE 2
VARIOUS CLASSIFICATIONS OF COSTS



Variable Costs, Fixed Costs, and Mixed Costs

From a planning and control standpoint, perhaps the most important way to classify costs is by how they behave in accordance with changes in volume or some measure of activity. By behavior, costs can be classified into the following three basic categories:

Variable costs are costs that vary in total in direct proportion to changes in activity. Examples are direct materials and gasoline expense based on mileage driven. **Fixed costs** are costs that remain constant in total regardless of changes in activity. Examples are rent, insurance, and taxes.

Mixed (or **semi-variable**) **costs** are costs that vary with changes in volume but, unlike variable costs, do not vary in direct proportion. In other words, these costs contain both a variable component and a fixed component. Examples are the rental of a delivery truck, where a fixed rental fee plus a variable charge based on mileage is made; and power costs, where the expense consists of a fixed amount plus a variable charge based on consumption.

Costs by behavior will be examined further in a later chapter. The breakdown of costs into their variable components and their fixed components is important in many areas of management accounting, such as flexible budgeting, break-even analysis, and short-term decision making.

Unit Costs and Total Costs

For external reporting and pricing purposes, accountants are frequently interested in determining the unit (average) cost per unit of product or service. The **unit cost** is simply the average cost, which is the total costs divided by the total volume in units. Alternatively, the unit cost is the sum of (a) the variable cost per unit, and (b) the fixed cost per unit. It is important to realize that the unit cost declines as volume increases since the total fixed costs that are constant over a range of activity are being spread over a larger number of units.

EXAMPLE 1

Fixed costs are $1,000 per period and variable costs are $.10 per unit. The total and unit (average) costs at various production levels are as follows:

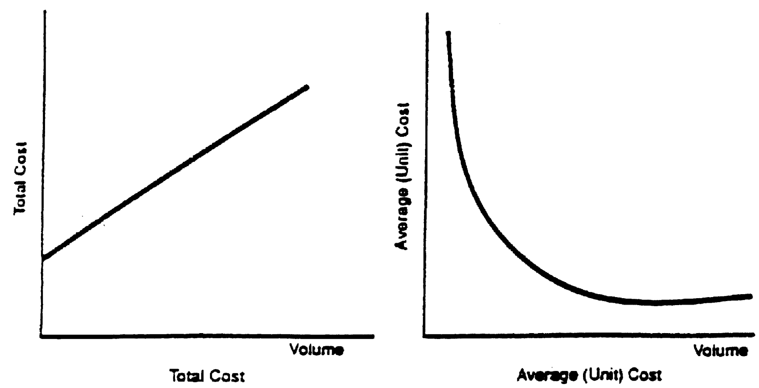
Volume in units (a)	**Total Fixed Costs** (b)	**Total Variable Costs** (c)	**Total Costs** (b)+(c) = (d)	**Variable Cost per unit** (c)/(a) = (e)	**Fixed Cost per unit** (b)/(a) = (f)	**Unit Average Cost** (d)/(a) or (e)+(f)
1,000	$1,000	$ 100	$1,100	$.10	$1.00	$1.10
5,000	1,000	500	1,500	.10	.20	.30
10,000	1,000	1,000	2,000	.10	.10	.20

The increase in total costs and the decline in unit costs are illustrated in Figure 3. Also note the relationships for variable and fixed costs per unit:

Behavior as Volume Changes from 5,000 to 10,000		
	Total	*Per Unit*
Variable Cost	Change ($500 to $1,000)	No change ($.10)
Fixed Cost	No change ($1,000)	Change ($.20 to $.10)

FIGURE 3

TOTAL AND UNIT (AVERAGE) COSTS



Costs for Planning, Control, and Decision Making

SUNK COSTS. Sunk costs are the costs of resources that have already been incurred whose total will not be affected by any decision made now or in the future. Sunk costs are considered irrelevant to future decisions since they are *past or historical* costs. For example, the acquisition cost of machinery is irrelevant to a decision of whether to scrap the machinery.

EXAMPLE 2

Suppose you acquired an asset for $50,000 three years ago which is now listed at a book value of $20,000. The $20,000 book value is a sunk cost which does not affect a future decision.

INCREMENTAL (OR DIFFERENTIAL) COSTS. The incremental cost is the difference in costs between two or more alternatives. Incremental costs are increases or decreases in total costs; or changes in specific elements of cost (e.g., direct labor cost), that result from any variation in operations. Incremental costs will be incurred (or saved) if a decision is made to go ahead (or to stop) some activity, but not otherwise.

EXAMPLE 3

Consider the two alternatives A and B whose costs are as follows:

	A	*B*	*Difference (B - A)*
Direct materials	$10,000	$10,000	$ 0
Direct labor	10,000	15,000	5,000

The incremental costs are simply B-A (or A - B) as shown in the last column. The incremental costs are relevant to future decisions, which will be taken up in detail in Chapter 11.

RELEVANT COSTS. Relevant costs are *expected future* costs that will differ between alternatives. This concept is a key to short- and long-term decisions and discussed in detail in Chapter 11.

EXAMPLE 4

The incremental cost is said to be relevant to the future decision. The sunk cost is considered irrelevant.

OUT-OF-POCKET COSTS. Out-of-pocket costs, also known as *outlay costs* or *cash costs*, are costs that require future expenditures of cash or other resources. Non-cash charges such as depreciation and amortization are *not* out-of-pocket costs. These are *book costs*. Out-of-pocket costs are usually relevant to a particular decision.

EXAMPLE 5

A capital investment project requires $120,000 in cash outlays. $120,000 is an out-of-pocket cost.

OPPORTUNITY COSTS. An opportunity cost is the net benefit foregone by using a resource for one purpose instead of for another. There is always an opportunity cost involved in making a choice decision. It is a cost incurred relative to the *best* alternative given up.

EXAMPLE 6

Suppose a company has a choice of using its capacity to produce an extra 10,000 units or renting it out for $20,000. The opportunity cost of using the capacity is $20,000.

CONTROLLABLE AND NONCONTROLLABLE COSTS. A cost is said to be controllable when the amount of the cost is assigned to the head of a department and the level of the cost is significantly under the manager's influence. For example, marketing executives control advertising costs. Noncontrollable costs are those costs not subject to influence at a given level of managerial supervision.

EXAMPLE 7

All variable costs such as direct materials, direct labor, and variable overhead are usually considered controllable by the department head. On the other hand, fixed costs such as depreciation of factory equipment would not be controllable by the department head, since he/she would have no power to authorize the purchase of the equipment.

STANDARD COSTS. Standard costs are the costs established in advance to serve as goals, norms or yardsticks to be achieved and, after the fact, to determine how well those goals were met. They are based on the quantities and prices of the various inputs (e.g., direct materials, direct labor, and factory overhead) needed to produce output efficiently. Standard costs can also be set for service businesses.

EXAMPLE 8

The standard cost of materials per pound is obtained by multiplying standard price per pound by standard quantity per unit of output in pounds. For example, the standard price and quantity of material might be determined as follows:

Purchase price	$3.00	
Freight	0.12	
Receiving and handling	0.02	
Less: Purchase discounts	(0.04)	
Standard price per pound	$3.10	
Per bill of materials in pounds	1.2	
Allowance for waste and spoilage in lbs.	0.1	
Allowance for rejects in lbs.	0.1	
Standard quantity per unit of output	1.4	lbs.

Once the price and quantity standards have been set, the standard cost of material per unit of finished goods can be computed, as follows:

1.4 pounds x $3.10 = $4.34 per unit.

MERCHANDISING VERSUS MANUFACTURING ORGANIZATIONS

Merchandising firms and manufacturing companies prepare income statements and balance sheets for owners, creditors, and other outside parties. Both types of companies maintain levels of inventory and calculate gross margin using sales and cost of goods sold information. However, merchandising firms are less complex than manufacturing firms.

Merchandising

- Purchase products that are ready for resale
- Maintain only one inventory account on the balance sheet
- Include the cost of purchases in the calculation of cost of goods sold

Manufacturing organizations

- Design and manufacture products for sale
- Reflect three inventory accounts on the balance sheet
- Determine the cost of goods manufactured to include in the calculation of cost of goods sold

Merchandising organizations, such as Wal-Mart, Rite Aid, and Office Depot, purchase products that are ready for resale. These organizations maintain one inventory account, called Merchandise Inventory, which reflects the costs of products held for resale. To calculate the cost of goods sold for a merchandising organization, the equation is used:

Cost of Goods Sold =	Beginning Merchandise Inventory	+	**Net Cost of Purchase**	–	Ending Merchandise Inventory

For example, Allison Candy Store had a balance of $3,000 in the Merchandise Inventory account on January 1, 20x0. During the year, the store purchased candy products totaling $23,000 (adjusted for purchase discounts, purchases returns and allowances, and freight-in). At December 31,20x0, the Merchandise Inventory balance was $4,500. The cost of goods sold is thus $21,500.

Cost of Goods Sold = $3,000 + $23,000 - $4,500 = $21,500

Manufacturing firms, such as Nokia, GM, and IBM, use materials, labor, and manufacturing overhead to manufacture products for sale. Materials are purchased and used in the production process. The Materials Inventory account shows the balance of the cost of unused materials. During the production process, the costs of manufacturing the product are accumulated in the Work in Process Inventory account. The balance of the Work in Process Inventory account represents the costs of unfinished product.

Once the product is complete and ready for sale, the cost of the goods manufactured is reflected in the Finished Goods Inventory account. The balance in the Finished Goods Inventory account is the cost of unsold completed product. When the product is sold, the manufacturing organization calculates the cost of goods sold using the following equation:

Cost of Goods Sold =	Beginning Finished Goods Inventory	+	**Cost of Goods Manufactured**	–	Ending Finished Goods Inventory

INCOME STATEMENTS AND BALANCE SHEETS--MANUFACTURER

Figure 5 illustrates the income statement of a manufacturer. An important characteristic of the income statement is that it is supported by a schedule of cost of goods manufactured (see Figure 6).

This schedule shows the specific costs (i.e., direct materials, direct labor, and factory overhead) that have gone into the goods completed during the period. The two most important figures on the cost of goods manufactured statement are (1) the total manufacturing costs and (2) the cost of goods manufactured. Be sure not to confuse the terms *total manufacturing costs* and *cost of goods manufactured.* **Total manufacturing cost** includes the costs of all *resources* put into production during the period.

Cost of goods manufactured consists of the total costs of all goods completed during the period and includes "total manufacturing cost" *plus* the beginning work in process inventory *minus* the ending work in process inventory. This adjustment process is necessary because total manufacturing cost could include the goods unfinished (work in process), which need to be taken out.

Since the manufacturer carries three types of inventory (direct materials, work-in-process, and finished goods) all three items must be incorporated into the computation of the cost of goods sold. These inventory accounts also appear on the balance sheet for a manufacturer, as shown in Figure 4.

YOU SHOULD REMEMBER

1. **Cost of direct materials used** =

Beginning direct materials inventory
\+ Purchases
\- Ending direct materials inventory

2. **Total manufacturing cost** =

Direct materials used
\+ direct labor
\+ factory overhead

3. **Cost of goods manufactured** =

Total manufacturing cost
\+ Beginning work in process inventory
\- Ending work in process inventory

4. **Cost of goods sold** =

Beginning finished goods inventory
\+ Cost of goods manufactured
\- Ending finished goods inventory

FIGURE 4

MANUFACTURER'S CURRENT ASSET SECTION OF BALANCE SHEET

December 31, 20X0

Current Assets:		
Cash		$ 25,000
Accounts Receivable		78,000
Inventories:		
Raw Materials	$ 7,800	
Work-in-Process	2,000	
Finished Goods	21,000	30,800
Total		$133,800

FIGURE 5

MANUFACTURER'S INCOME STATEMENT

For the Year Ended December 31, 20X0

Sales		$460,000
Cost of goods sold:		
Beginning finished goods inventory	$ 18,000	
Add: Cost of goods manufactured (see Schedule, Figure 6)	261,000	
Cost of goods available for sale	$279,000	
Less: Ending finished goods inventory	(21,000)	$258,000
Gross margin		$202,000
Less: Operating expenses		
Selling and administrative expenses		(70,000)
Net Income before taxes		$132,000

FIGURE 6

MANUFACTURER'S

SCHEDULE OF COST GOODS MANUFACTURED

Direct materials:				
Beginning inventory	$ 23,000			
Add: Purchases	64,000			
Direct materials available for use		$87,000		
Less: Ending inventory		(7,800)		
Direct materials used			$ 79,200	
Direct labor			45,000	
Factory overhead:				
Indirect labor	$13,000			
Indirect material	12,000			
Factory utilities	10,500			
Factory depreciation	10,800			
Factory rent	12,000			
Miscellaneous	71,500			
			129,800	
Total manufacturing costs incurred during 20x0				$254,000
Add: Beginning work-in-process inventory				9,000
Manufacturing costs to account for				$263,000
Less: Ending work-in-process inventory				(2,000)
Cost of goods manufactured (to income statement, Figure 5)				$261,000

The Contribution Income Statement

The traditional (absorption) income statement for external reporting shows the functional classification of costs, that is, manufacturing costs vs. non-manufacturing expenses (or operating expenses). An alternative format of income statement, known as the *contribution income statement,* organizes the costs by behavior rather than by function. It shows the relationship of variable costs and fixed costs a given cost item is associated with, regardless of the functions.

The contribution approach to income determination provides data that are useful for managerial planning and decision making. For example, the contribution approach is useful:

(1) For break-even and cost-volume-profit analysis,
(2) In evaluating the performance of the division and its manager, and
(3) For short-term and non-routine decisions.

The contribution income statement is not acceptable, however, for income tax or external reporting purposes because it ignores fixed overhead as a product cost. The statement highlights the concept of contribution margin, which is the difference between sales and variable costs. The traditional format, on the other hand, emphasizes the concept of gross margin, which is the difference between sales and cost of goods sold.

These two concepts are independent and have nothing to do with each other. Gross margin is available to cover non-manufacturing expenses, whereas contribution margin is available to cover fixed costs. The concept of contribution margin has numerous applications for internal management, which will be taken up in Chapter 11.

A comparison is made between the traditional format and the contribution format below.

TRADITIONAL FORMAT

Sales		$15,000
Less: Cost of Goods Sold		7,000
Gross Margin		8,000
Selling	$2,100	
Administrative	1,500	3,600
Net Income		$4,400

Assuming the variable cost of goods sold, $4,000, variable selling expenses, $1,600, and variable administrative expenses, $500, the traditional format can be converted into the contribution format as follows.

CONTRIBUTION FORMAT

Sales		$15,000
Less: Variable Expenses		
Manufacturing	$4,000	
Selling	1,600	
Administrative	500	6,100
Contribution Margin		8,900
Less: Fixed Expenses		
Manufacturing	$3,000	
Selling	500	
Administrative	1,000	4,500
Net Income		$4,400

CHAPTER SUMMARY

Cost accounting is the accumulation and analysis of cost data to provide information for external reporting, for internal planning and control of an organization's operations, and for short-term and long-term decisions. It is important to realize that there are different costs used for different purposes. The cost/management must determine how to use cost data in order to supply the most appropriate cost information.

Cost/managerial accountants prepare the income statement in a contribution format which organizes costs by behavior rather than by the functions of manufacturing, sales, and administration. The contribution income statement is widely used as an internal planning and decision-making tool.

CHAPTER 3
COST ACCOUNTING SYSTEMS— JOB ORDER COSTING

A cost accumulation system is a product costing system. This process accumulates manufacturing costs such as materials, labor and factory overhead and assigns them to cost objectives, such as finished goods and work-in-process. Product costing is necessary not only for inventory valuation and income determination but also for establishing the unit sales price.

We will discuss the essentials of the cost accumulation system that is used to measure the manufacturing costs of products. This is essentially a two-step process: (1) the measurement of costs that are applicable to manufacturing operations during a given accounting period and (2) the assignment of these costs to products.

There are two basic approaches to cost accounting and accumulation:

(1) Job order costing
(2) Process costing (to be discussed in Chapter 14).

After studying the material in this chapter, you will be able to

- Explain job order costing.
- List the componets of a job cost sheet.
- Prepare journal entries for a job order cost system.
- Deevelop a predetermined overhead rate.
- Dispose of overapplied or underapplied overhead.

JOB ORDER COSTING AND PROCESS COSTING COMPARED

The distinction between job order costing and process costing centers largely around how product costing is accomplished. With job order costing, the focus is to apply costs to specific jobs, which may consist of either a single physical unit or a few like units.

Under process costing, accounting data are accumulated by the production department (or cost center) and averaged over all of the production that occurred in the department. Here there is mass production of like units which are manufactured on a continuous basis through a series of uniform production steps known as *processes*. Figure 1 summarizes the basic differences between these two methods.

FIGURE 1

DIFFERENCES BETWEEN JOB ORDER COSTING AND PROCESS COSTING

	Job Order Costing	***Process Costing***
1. Cost unit	Job, order, or contract	Physical unit
2. Costs are accumulated	By jobs	By departments
3. Subsidiary record	Job cost sheet	Cost of production report
4. Used by	Custom manufacturers	Processing industries
5. Permits computation of	(a) A unit cost for inventory costing purposes (b) A profit or loss on each job	A unit cost to be used to compute the costs of goods completed and work in process

JOB ORDER COSTING

Job order costing is the cost accumulation system under which costs are accumulated by jobs, contracts, or orders. This costing method is appropriate when the products are manufactured in identifiable lots or batches or when the products are manufactured to customer specifications. Job order costing is widely used by custom manufacturers such as printing, aircraft, and construction companies. It may also be used by service businesses such as auto repair shops and professional services. Job order costing keeps track of costs as follows: direct material and direct labor are traced to a particular job. Costs not directly traceable--factory overhead--are applied to individual jobs using a predetermined overhead (application) rate.

JOB COST RECORDS

A *job cost sheet* is used to record various production costs for work-in-process inventory. A separate cost sheet is kept for each identifiable job, accumulating the direct materials, direct labor, and factory overhead assigned to that job as it moves through production. The form varies according to the needs of the company. Figure 2 presents the basic records or source documents used for job costing.
These include:

1. The *job cost sheet*. This is the key document in the system. It summarizes all of the manufacturing costs --direct materials, direct labor, and applied factory overhead (to be discussed in detail later)--of producing a given job or batch of products. One sheet is maintained for each job, and the file of job cost sheets for unfinished jobs is the subsidiary record for the Work in Process Inventory account. When the jobs are completed and transferred, the job order sheets are transferred

to a completed jobs file and the number of units and their unit costs are recorded on inventory cards supporting the Finished Goods Inventory account.

2. The *materials requisition form*. This form shows the types, quantities and prices of each type of material issued for production.

3. The *work ticket*. It shows who worked on what job for how many hours and at what wage rate. This is also called *time ticket* and illustrated in Figure 2.

4. The *factory overhead cost sheet.* It summarizes the various factory overhead costs incurred.

5. The *memo for applied factory overhead*. This is a memorandum that shows how the factory overhead applied rate has been developed.

6. The *finished goods record.* This is a record maintained for each type of product manufactured and sold. Each record contains a running record of units and costs of products received, sold, and on hand.

The general flow of costs through a job cost system is shown in Figure 3.

JOB ORDER COSTING - ILLUSTRATION

To illustrate a job order cost system, especially the tie-in between the general ledger accounts and the subsidiary records, examine the information presented below.

This illustration covers the month of June, for which the beginning inventories were:

Materials inventory (Material A, \$10,000; Material B, \$6,000; indirect materials \$4,000)	\$20,000
Work-in-process inventory (Job No. 310; direct materials, \$4,200; direct labor, \$5,000; and overhead, \$4,000)	13,200
Finished goods inventory (500 units of Product X at a cost of \$11 per unit)	5,500

Assume that Job No. 310 was completed in June, and that, of the two jobs started in June (Nos. 320 and 510), only Job No. 510 is incomplete at the end of June. The transactions, and the journal entries to record them, are given below:

1. Purchased \$10,000 of Material A and \$15,000 of Material B on account.

Materials Inventory	25,000	
Accounts Payable		25,000

To record purchase of direct materials.

2. Issued direct materials: Material A to Job No. 310, $1,000; to Job No. 320, $8,000; and to Job No. 510, $2,000; Material B to Job No. 310, $2,000; to Job No. 320, $6,000; and to Job No. 510, $4,000. Indirect materials issued to all jobs, $1,000.

Work-in-Process Inventory	23,000	
Factory Overhead	1,000	
Material Inventory		24,000

To record direct and indirect materials issued.

3. Factory payroll for the month, $25,000; social security and income taxes withheld, $4,000.

Payroll Summary	25,000	
Various liability accounts for taxes withheld		4,000
Accrued Wages Payable		21,000

To record factory payroll for June.

4. Factory payroll paid, $19,000.

Accrued Wages Payable	19,000	
Cash		19,000

To record cash paid to factory employees in June.

5. Payroll costs distributed: direct labor, $20,000 (Job No. 310, $5,000; Job No. 320, $12,000; and Job No. 510, $3,000); and indirect labor, $5,000.

Work-in-Process Inventory	20,000	
Factory Overhead	5,000	
Payroll Summary		25,000

To distribute factory labor costs incurred.

FIGURE 2

BASIC RECORDS IN A JOB COST SYSTEM

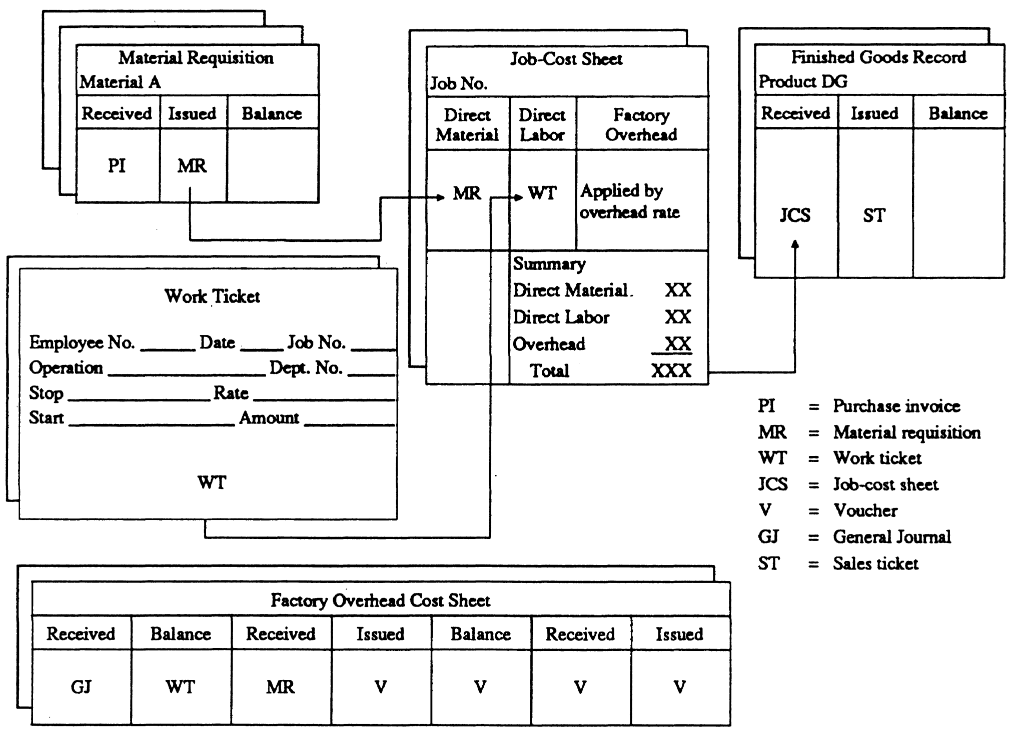
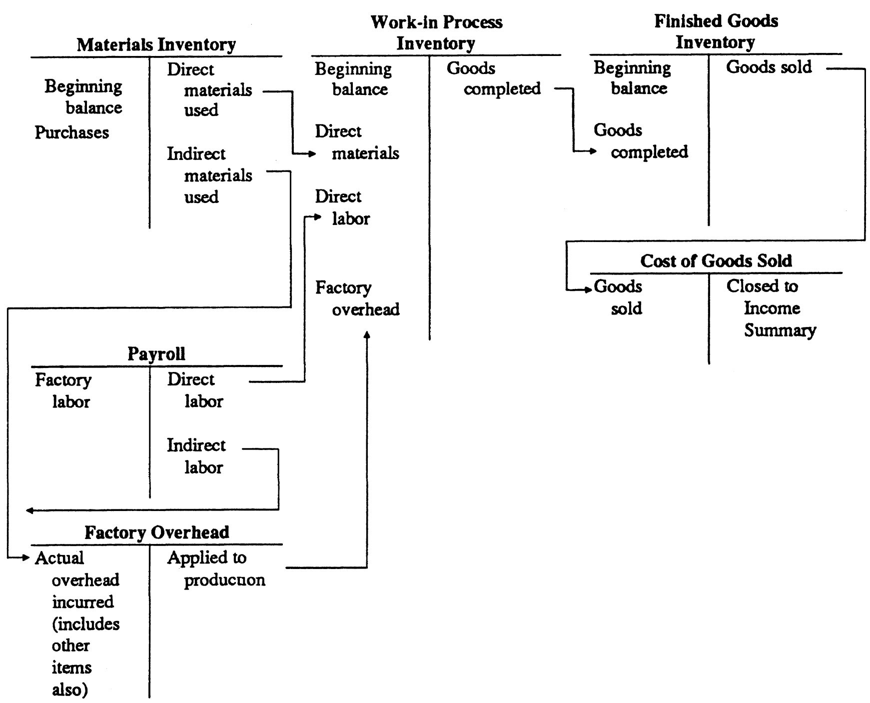


FIGURE 3

JOB COST SYSTEM - FLOW CHART OF LEDGER RELATIONSHIPS



6. Other factory overhead costs incurred:

Payroll taxes accrued	$3,000
Repairs (on account)	1,000
Property taxes accrued	4,000
Heat, light, and power (on account)	2,000
Depreciation	5,000
	$15,000

Factory Overhead	15,000	
Accounts Payable		3,000
Accrued Payroll Taxes		3,000
Accrued Property Taxes Payable		4,000
Accumulated Depreciation		5,000

To record factory overhead costs incurred.

7. Factory overhead applied to production (at rate of 80 percent of direct labor cost):

Job No. 310, Product Y (0.80 x $5,000)	$4,000
Job No. 320, Product Z (0.80 x $12,000)	9,600
Job No. 510, Product W (0.80 x $3,000)	2,400
	$16,000

Work in Process Inventory	16,000	
Factory Overhead		16,000

To record application of overhead to production.

It is important to note that as factory overhead costs are incurred, they are recorded in a subsidiary ledger and debited to the factory overhead account, as shown in journal entries nos. 2, 5, and

Note: The factory overhead costs applied to production are periodically credited to the factory overhead account and debited to the work-in-process account, as illustrated in journal entry no. 7). The issue of factory overhead application will be discussed in detail later in the chapter.

8. Jobs completed and transferred to finished goods inventory (see Figure 4 for details):

Job No. 310 (4,000 units of Product Y @ $6.30)	$25,200
Job No. 320 (10,000 units of Product Z @ $3.56)	35,600
	$60,800

Finished Good Inventory	60,800	
Work in Process Inventory		60,800

To record completed production for June.

9. Sales on account for the month: 500 units of Product X for $8,000, cost, $5,500; and 10,000 units of Product Z for $62,000, cost, $35,600 (Job No. 320).

Accounts Receivable	70,000	
Sales		70,000

To record sales on account ($8,000 + $62,000) for June.

Cost of Goods Sold	41,100	
Finished Goods Inventory		41,100

To record cost of goods sold ($5,500 + $35,600) for June.

After the above entries have been posted to the accounts of the company, the Work-in-Process Inventory and finished Goods Inventory accounts would appear (in T-account form) as follows:

Work-in-Process Inventory

June 1 balance	13,200	Completed	60,800
Direct materials used	23,000		
Direct labor cost incurred	20,000		
Overhead applied	16,000		

Finished Goods Inventory

June 1 balance	5,500	Sold	41,100
Completed	60,800		

The Work-in-Process Inventory account has a balance at June 28 of $11,400, which agrees with the total costs charged thus far to Job No. 510, as is shown in Figure 3.4. These costs consist of direct materials, $6,000; direct labor, $3,000, and factory overhead, $2,400. The Finished Goods Inventory account has a balance at June 28 of $25,200. The finished goods inventory card for Product Y supports this amount (see Figure 4), showing that there are indeed units of Product Y on hand having a total cost of $25,200.

Note that the entries in the ledger accounts given above are often made from summaries of costs and are thus entered only at the end of the month. On the other hand, in order to keep management informed as to costs incurred, the details of the various costs incurred may be recorded more frequently, often daily.

The above example should be studied until the real advantages of using overhead rates (including predetermined rates) are clear. Three jobs were worked on during the month. Job No. 310 was started last month and completed in June.

Job No. 320 was started and completed in June. And Job No. 510 was started but not finished in June. Each required different amounts of direct materials and direct labor (and, perhaps, different types of direct labor). Under these conditions, there is simply no way to apply overhead to products without the use of a rate based on some level of activity.

Note also that the use of a predetermined overhead rate permits the computation of unit costs of Job Nos. 310 and 320 at the time of their completion rather than waiting until the end of the month. But this advantage is secured only at the cost of keeping more detailed records of the costs incurred. As we shall see below, the other major cost system - process costing - requires far less record keeping, but the computation of unit costs is more complex.

EXAMPLE 1

Chiphard Works collects its cost data by the job order cost system. For Job 123, the following data are available:

Direct Materials		Direct Labor	
7/14 Issued	$1,200	Week of July 20	180 hrs. @$6.50
7/20 Issued	650	Week of July 26	140 hrs. @ 7.25
7/25 Issued	350		
	$2,200		

Factory overhead is applied at the rate of $4.50 per direct labor hour.

We will compute (a) the cost of Job 123 and (b) the sales price of the job, assuming that it was contracted with a markup of 40% of cost.

(a) The cost of job is:

Direct material		$2,200
Direct labor:		
180 hrs. x $6.50	$1,170	
140 hrs. x $7.25	1,015	2,185
Factory overhead applied:		
320 hrs. x $4.50		1,440
Cost of Job 123		$5,825

(b) The sales price of the job is:

$5,825 + 40% ($5,825) = $5,825 + $2,330 = $8,155

EXAMPLE 2

The following account appears in the ledger after only part of the postings have been completed for June:

Work-in-Process

Balance, June	$132,200
Direct Materials	134,500
Direct Labor	112,000

Factory Overhead	220,000
	$598,700

Jobs finished during June are summarized as follows:

Job 101	$56,700
Job 107	230,200
Job 111	127,500
	$414,400

We will prepare (a) the journal entry to record the jobs completed and (b) determine the cost of the unfinished jobs at June 30.

(a) The journal entry is:

Finished Goods	414,400	
Work in Process		414,400

(b) The cost of unfinished jobs is:

$598,700 - $414,400 = $184,300

FIGURE 4

JOB COST SHEETS AND SUPPORTING INVENTORY CARDS

Material Requisition
Material A

Received	Issued	Balance
		$10,000
$10,000		20,000
	$1,000	19,000
	8,000	11,000
	2,000	9,000

Material Requisition
Material B

Received	Issued	Balance
		$ 6,000
$15,000		21,000
	$2,000	19,000
	6,000	13,000
	4,000	9,000

Job Cost Sheet (Product Y) Job No. 310

Date	Direct Materials	Direct Labor	Factory Overhead Applied
June	$4,200	$ 5,000	$4,000
	A 1,000	5,000	4,000
	B 2,000	$10,000	$8,000
	$7,200		
	Job completed (4,000 units of Product Y @ $6.30). Total cost, $25,200.		

Job Cost Sheet (Product Z) Job No. 320

Date	Direct Materials	Direct Labor	Factory Overhead Applied
June	A 8,000	$12,000	$9,600
	B 6,000		
	$14,000		
	Job completed (10,000 units of Product Z @ $3.56). Total cost, $35,600.		

Job Cost Sheet (Product W) Job No. 510

Date	Direct Materials	Direct Labor	Factory Overhead Applied
June	A 2,000	$3,000	$2,400
	B 4,000		
	Job completed (4,000 units of Product W). Cost to date, $11,400.		

Finished Goods Record
Product X

Received	Issued	Balance
		$5,500
	$5,500	– 0 –

Finished Goods Record
Product Y

Received	Issued	Balance
$25,200		$25,200

Finished Goods Record
Product Z

Received	Issued	Balance
$35,600		$35,600
	$35,600	– 0 –

FACTORY OVERHEAD APPLICATION

Many items of factory overhead cost are incurred for the entire factory and for the entire accounting period and cannot be specifically identified with particular jobs. Furthermore, the amount of actual factory overhead costs incurred is not usually available until the end of the accounting period. But it is often critical to make cost data available for pricing purposes as each job is completed. Therefore, in order for job costs to be available on a timely basis, it is customary to apply factory overhead by using a *predetermined factory overhead rate.*

Note: Although an actual rate is simple to compute, the results are misleading because overhead rates may fluctuate significantly from month to month. When these fluctuations occur, similar jobs completed in different months will have overhead costs and total costs that differ.

Predetermined Factory Overhead Rate

Regardless of the cost accumulation system used (i.e., job order or process), factory overhead is applied to a job or process. Companies use *predicted* levels of activity and cost rather than *actual* levels. The successful assignment of factory overhead costs depends on a careful estimate the total overhead costs and a good forecast of the activity used as the cost driver.

The predetermined overhead rate is determined as follows:

$$\text{Predetermined overhead rate} = \frac{\text{Budgeted annual factory overhead costs}}{\begin{array}{l}\text{Budgeted annual activity units}\\ \text{(direct labor hours, machine hours etc)}\end{array}}$$

Budgeted activity units used in the denominator of the formula, more often called the *denominator activity* level or *cost driver*, are measured in

(1) direct labor hours
(2) machine hours
(3) direct labor costs
(4) direct material dollars or
(5) production units.

Note: In capital-intensive industries (e.g., industries using robotics), the amount of overhead will probably be related more to machine hours than to either direct labor hours of direct labor cost. In labor-intensive industries (e.g. industries using manual labor), factory overhead is traditionally assigned on the basis of labor time. However, if more overhead is incurred by the more highly skilled and paid employees, the factory overhead rate should be based upon direct labor dollars rather than direct labor hours.

Deposition of Under – and Over – Applied Overhead

Inevitably, actual overhead cost incurred and during a period and factory overhead costs applied will differ. Conventionally, at the end of the year, the difference between actual overhead and applied overhead is closed to cost of goods sold if it is immaterial. On the other hand, if a material difference exists, work-in-process, finished goods, and cost of goods sold are adjusted on a proportionate basis based on units or dollars at year-end for the deviation between actual and applied overhead. Underapplied overhead and overapplied overhead results as follows:

Underapplied overhead = Applied overhead < Actual overhead
Overapplied overhead = Applied overhead > Actual overhead

EXAMPLE 3

Two companies have prepared the following budgeted data for the year 20X1:

	Company X	**Company Y**
Predetermined rate based on	Machine hours	Direct labor cost
Budgeted overhead	$200,000 (1)	$240,000 (1)
Budgeted machine-hours	100,000 (2)	
Budgeted direct labor cost		$160,000 (2)
Predetermined overhead rate (1)/(2)	$2 per machine hour	150% of direct labor cost

Now assume that actual overhead costs and the actual level of activity for 20X1 for each firm are shown as follows:

	Company X	**Company Y**
Actual overhead costs	$198,000	$256,000
Actual machine hours	96,000	
Actual direct labor cost		$176,000

Note that for each company, the actual cost and activity data differ from the budgeted figures used in calculating the predetermined overhead rate. The computation of the resulting underapplied and overapplied overhead for each company is provided below:

	Company X	**Company Y**
Actual overhead costs	$198,000	$256,000
Factory overhead applied to Work-in-Process during 20X1:		
96,000 actual machine-hours x $2	192,000	
$176,000 actual direct labor cost x 150%		264,000
Underapplied (overapplied) factory overhead	$ 6,000	($ 8,000)

Plantwide versus Departmental Overhead Rates

As the degree of aggregation increases from simply combining related cost pools to combining all factory overhead, information may become more distorted. The following information is used to provide a simple example of the differing results obtained between using a departmental and plantwide overhead rate.

EXAMPLE 4

Allison Company has two departments: assembly and finishing. Assembly work is performed by robots, and a large portion of this department's overhead cost consists of depreciation and electricity charges. Finishing work is performed manually by skilled laborers, and most charges in this department are for labor, fringe benefits, indirect materials, and supplies.

The company makes two products: A and B. Product A requires five machine hours in assembly and one direct labor hour in finishing; Product B requires two machine hours in assembly and three direct labor hours in finishing.

Figure 5 provides information about estimated overhead costs and activity measures and shows the computations of departmental and plantwide overhead rates. Product overhead application amounts for A and B are also given.

Note the significant difference in the overhead applied to each product using departmental versus plantwide rates. If departmental rates are used, product cost more clearly reflects the different amounts and types of machine/labor work performed on the two products. If a plantwide rate is used, essentially, each product only absorbs overhead from a single department--from Assembly if machine hours are used and from Finishing if direct labor hours are used. Use of a plantwide rate ignores the dissimilarity of work performed in the departments.

FIGURE 5
PLANTWIDE VERSUS DEPARTMENTAL OVERHEAD RATES

	Assembly	*Finishing*	*Total*
Estimated annual overhead	$300,200	$99,800	$400,000
Estimated annual direct labor hours (DLH)	5,000	20,000	25,000
Estimate annual machine hours (MH)	38,000	2,000	40,000

Hours used	*Product A*	*Product B*
Labor hours	1	3
Machine hours	5	2

(1)	Total plantwide overhead =	$300,200 + $99,800 = $400,000
	Plantwide overhead rate using DLH)	($400,000/25000 = $16.00)
(2)	Departmental overhead rates:	
	Assembly (automated)	$300,200/38,000 = $7.90 per MH
	Finishing (manual)	$99,800/20,000 = $4.99 per DLH

		To Product A	*To Product B*
(1)	Overhead assigned using plantwide rate: based on DLH	1($16.00) = **$16.00**	3($16.00) = **$48.00**
(2)	Overhead assigned using departmental rates:		
	Assembly	5 ($7.90) = $39.50	2 ($7.90) = $15.80
	Finishing	1 ($4.99) = 4.99	3 ($4.99) = 14.97
	Total	**$44.49**	**$30.77**

Use of plantwide overhead rates rather than departmental rates may also contribute to problems in product pricing. While selling prices must be reflective of market conditions, management typically uses cost as a starting point for setting prices. If plantwide rates distort the true cost of a product, selling prices might be set too low or too high, causing management to make incorrect decisions.

EXAMPLE 5

Assume in the case of Allison Company that direct materials and direct labor costs for product A are $5 and $35, respectively. Adding the various overhead amounts to these prime costs gives the total product cost under each method. Figure 6 shows these product costs and the profits or loss that would be indicated if Product A has a normal market selling price of $105.

Use of the product costs developed from plantwide rates could cause Allison management to make erroneous decisions about Product A. If the cost figure developed from a plantwide direct labor hour basis is used, management may think that Product A is significantly more successful than it actually is. Such a decision could cause resources to be diverted from other products. If the cost containing overhead based on the plantwide machine hour allocation is used, management may believe that Product A should not be produced, because it appears not to be generating a very substantial gross profit.

In either instance, assuming that machine hours and direct labor hours are the best possible allocation bases for assembly and finishing, respectively, the only cost that gives management the necessary information upon which to make resource allocation and product development/elimination decisions is the one produced by using the departmental overhead rates.

FIGURE 6

TOTAL PRODUCT COSTS AND PROFITS

	Departmental Rates	*Plantwide Rate (DLH)*
Direct materials	$ 5.00	$ 5.00
Direct labor	35.00	35.00
Overhead	44.49	16.00
Total Cost	$ 84.49	$ 56.00
Selling Price	$105.00	$105.00
Gross profit (margin)	$ 20.51	$ 49.00
Profit margin	19.5%	46.7%

EXAMPLE 6

A company uses a budgeted overhead rate in applying overhead to production orders on a labor-cost basis for Department A and on a machine-hour basis for Department B. At the beginning of the year, the company made the following predictions:

	Department A	*Department B*	*Total*
Budgeted factory overhead	$72,000	$75,000	$147,000
Budgeted direct labor cost	64,000	17,500	81,500
Budgeted machine hours	500	10,000	10,500

The predetermined overhead rates for each department are:

Department A: $72,000/$64,000 = $1.125 per labor dollar or 112.5%
Department B: $75,000/10,000 = $7.50 per machine hour

During the month of January, the cost record for a job order, No. 105, which was processed through both departments, shows the following:

	Department A	*Department B*	*Total*
Materials issued	$30	$45	$75
Direct labor cost	36	25	61
Machine hours	6	15	21

The total applied overhead for job order No. 105 follows:

Department A: $36 x 1.125	$40.50
Department B: 15 x $7.50	112.50
	$153.00

Assume job order No. 105 consisted of 30 units of product, what is the total cost and unit cost of the job?

	Department A	*Department B*	*Total*
Direct material	$30.00	$45.00	$75.00
Direct labor	36.00	25.00	61.00
Applied overhead	40.50	112.50	153.00
Total	$106.50	$182.50	$289.00

Hence, the total cost of the job is $106.50 + $182.50 = $289; the unit cost is $ 9.63 ($289/30 units).

EXAMPLE 7

Refer to Example 6 and assume that the company uses a single plant-wide rate based on direct labor costs. What is (a) the total applied overhead for job order No. 105 and (b) the total cost and unit cost of the job?

The predetermined overhead rate is:

$147,000/$81,500 = 180% of direct labor cost

Then the total applied overhead for the job is:

$61 x 180% = $109.80 (as compared to $153.00 under a department rate system)

Therefore, the total cost of the job is $245.80 ($75.00+$61.00+$109.80); the unit cost is $8.19 ($245.80/ units)

Notice the difference in the unit cost $8.19 versus $9.63.

EXAMPLE 8

Refer to Example 6 and assume, at the end of the year, that actual factory overhead amounted to $80,000 in Department A and $69,000 in Department B. Assume further that the actual direct labor cost was $74,000 in Department A and the actual machine hours were 9,000 in Department B.

Then, the overapplied or underapplied overhead for each department would be:

Department A:	Applied overhead (1.125 x $74,000)	$83,250
	Actual overhead	80,000
	Overapplied overhead	$ 3,250
Department B:	Applied overhead ($7.50 x 9,000)	$67,500
	Actual overhead	69,000
	Underapplied overhead	$(1,500)

CHAPTER SUMMARY

Unit costs are necessary for inventory valuation, income determination, and pricing. This chapter provided an introduction to the two basic cost accumulation systems: (1) job order costing and (2) process costing. Job order costing was discussed in detail.

Job order costing attaches costs to specific jobs by means of cost sheets established for each job. Direct material and direct labor costs are traced to specific jobs; factory overhead costs are applied by jobs, using a predetermined overhead rate. This chapter also discussed ways in which to develop the overhead application rate. We discuss process cost accounting in Chapter 14 (Process Costing, Cost Allocation, and Joint Product Costing).

CHAPTER 4
ACTIVITY-BASED COSTING

Many companies use a traditional cost system such as job-order costing or process costing, or some hybrid of the two. This traditional system may provide distorted product cost information. In fact, companies selling multiple products are making critical decisions about product pricing, making bids, or product mix, based on inaccurate cost data. In all likelihood, the problem is not with assigning the costs of direct labor or direct materials. These prime costs are traceable to individual products, and most conventional cost systems are designed to ensure that this tracing takes place.

However, the assignment of overhead costs to individual products is another matter. Using the traditional methods of assigning overhead costs to products, using a single predetermined overhead rate based on any single activity measure, can produce distorted product costs. The growth in the automation of manufacturing (such as increased use of robotics, high-tech machinery, and other computer-driven processes) has changed the nature of manufacturing and the composition of total product cost. The significance of direct labor cost has diminished and overhead costs have increased. In this environment, overhead application rates based on direct labor or any other volume-based cost driver may not provide accurate overhead charges since they no longer represent cause and effect relationships between output and overhead costs.

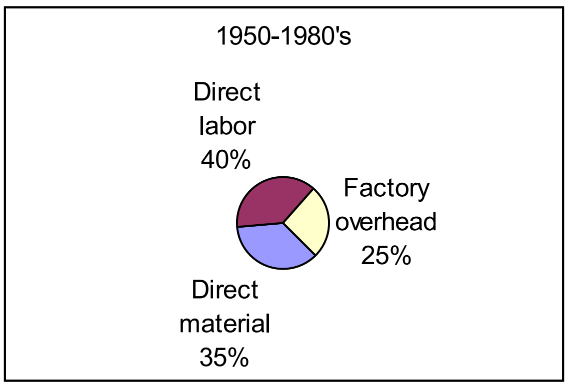
Activity-based costing (ABC) attempts to get around this problem. An ABC system assigns costs to products based on the product's use of activities, not product volume. It has proved to produce more accurate product costing results in an environment where there is diversity in product line and services coming out of the same shop. A recent survey by the Institute of Management Accounting shows that over 30 percent of the companies responded are using ABC systems to replace their existing tradition cost systems.

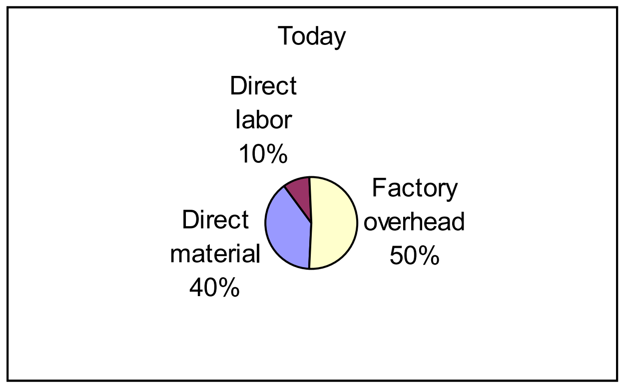
After studying the material in this chapter, you will be able to

- Explain the problems associated with traditional overhead costing methods.
- Dscribe how *activity-based costing (ABC)* would enhance product costing accuracy.
- Ilustrate the two-step procedure involved in activity-based costing.
- Associate different cost drivers with different cost pools.
- Discuss what *activity-based management (ABM)* is.

COMPOSITION OF PRODUCT COST

Technology and automation of the 1990s have produced entirely new patterns of product costs. The three elements of product cost are still direct materials, direct labor, and factory (manufacturing) overhead. However, the percentage that each element contributes to the total cost of a product has changed. Prior to 1980s, direct labor was the dominant cost element, making up over 40 percent of total product cost. Direct materials contributed 35 percent and manufacturing overhead around 25 percent of total cost. Seventy-five percent of total product cost was a direct cost, traceable to the product. Improved production technology caused a dramatic shift in the three products cost elements. Labor was replaced by machines, and direct labor was reduced significantly. Today, only 50 percent of the cost of a product is directly traceable to the product; the other 50 percent is manufacturing overhead, an indirect cost.





OVERHEAD COSTING: A SINGLE-PRODUCT SITUATION

The accuracy of overhead cost assignment becomes an issue only when multiple products are manufactured in a single facility. If only a single product is produced, all overhead costs are caused by it and traceable to it. The overhead cost per unit is simply the total overhead for the year divided by the number of hours or units produced, which was discussed in detail in the previous chapters.

The cost calculation for a single-product setting is illustrated in Table 1. There is no question that the cost of manufacturing the product illustrated in Table 1 is $ 28.00 per unit. All manufacturing costs were incurred specifically to make this product. Thus, one way to ensure product-costing accuracy is to focus on producing one product. For this reason, some multiple product firms choose to dedicate entire plants to the manufacture of a single product.

By focusing on only one or two products, small manufacturers are able to calculate the cost of manufacturing the high-volume products more accurately and price them more effectively.

TABLE 1

UNIT COST COMPUTATION: SINGLE PRODUCT

	Manufacturing Costs	*Produced Units*	*Unit Cost*
Direct materials	$800,000	50,000	$16.00
Direct labor	200,000	50,000	4.00
Factory overhead	400,000	50,000	8.00
Total	$1,400,000	50,000	$28.00

OVERHEAD COSTING: A MULTIPLE-PRODUCT SITUATION

In a multiple-product or multi-job situation, manufacturing overhead costs are caused jointly by all products. The problem is one of trying to identify the amount of overhead caused or consumed by each. This is accomplished by searching for *cost drivers*, or activity measures that cause costs to be incurred.

In a traditional setting, it is normally assumed that overhead consumption is highly correlated with the volume of production activity, measured in terms of direct labor hours, machine hours, or direct labor dollars. These volume-related cost drivers are used to assign overhead to products. Volume-related cost drivers use either *plant-wide* or *departmental* rates, which was discussed in detail in the previous chapter.

EXAMPLE 1

To illustrate the limitation of this traditional approach, assume that Aggie Manufacturing Company has a plant that produces two high-quality fertilizer products; Nitro-X and Nitro-Y. Product costing data are given in Table 2. Because the quantity of Nitro-Y produced is five times greater than that of Nitro-X, Nitro-X can be labeled a low-volume product and Nitro-Y a high-volume product.

For simplicity, only four types of factory overhead costs are assumed: setup, quality control, power, and maintenance. These overhead costs are allocated to the two production departments using the *direct* method.

Assume that the four service centers do not interact. Setup costs are allocated based on the number of production runs handled by each department. Quality control costs are allocated by the number of inspection hours used by each department. Power costs are allocated in proportion to the kilowatt hours used. Maintenance costs are allocated in proportion to the machine hours used.

Plant-Wide Overhead Rate

A common method of assigning overhead to products is to compute a plant-wide rate, using a volume-related cost driver. This approach assumes that all overhead cost variation can be explained by one cost driver. Assume that machine hours are chosen.

TABLE 2

PRODUCT COSTING DATA

	Nitro-X	*Nitro-Y*	*Total*
Units produced per year	10,000	50,000	60,000
Production runs	20	30	50
Inspection hours	800	1,200	2,000
Kilowatt hours	5,000	25,000	30,000
Prime costs (direct materials and direct labor)	$50,000	$250,000	$300,000

Departmental Data

	Department 1	*Department 2*	*Total*
Direct labor hours:			
Nitro-X	4,000	16,000	20,000
Nitro-Y	76,000	24,000	100,000
Total	80,000	40,000	120,000
Machine hours:			
Nitro-X	4,000	6,000	10,000
Nitro-Y	16,000	34,000	50,000
Total	20,000	40,000	60,000
Overhead costs:			
Setup costs	$48,000	$48,000	$96,000
Quality control	37,000	37,000	74,000
Power	14,000	70,000	84,000
Maintenance	13,000	65,000	78,000
Total	$112,000	$220,000	$332,000

Dividing the total overhead by the total machine hours yields the following overhead rate:

Plant-wide rate = $332,000/60,000

= $5.53/machine hour

Using this rate and other information from Table 2, the unit cost for each product can be calculated, as given in Table 3.

TABLE 3

UNIT COST COMPUTATION: PLANT-WIDE RATE

Nitro-X

Prime costs	$50,000
Overhead costs $5.53 X 10,000	55,300
	$105,300
Unit cost $105,300/10,000 units	$10.53

Nitro-Y

Prime costs	$250,000
Overhead costs $5.53 X 50,000	276,500
	$526,500
Unit cost $526,500/50,000 units	$10.53

Departmental Rates

Based on the distribution of labor hours and machine hours in Table 2, Department 1 is labor intensive and Department 2 machine oriented. Furthermore, the overhead costs of Department 1 are about one half those of Department 2. Based on these observations, it is obvious that departmental overhead rates would reflect the consumption of overhead better than a plant-wide rate. Product costs would be more accurate, using departmental rates rather than a plant-wide rate.

This approach would yield the following departmental rates, using direct labor hours for Department 1 and machine hours for Department 2:

Department 1 rate	= $112,000/80,000
	= $1.40/labor hour
	= $5.53/machine hour
Department 2 rate	= $220,000/40,000
	= $5.50/machine hour

Using these rates and the data from Table 2, the computation of the unit costs for each product is shown in Table 4.

TABLE 4
UNIT COST COMPUTATION: DEPARTMENT RATES

Nitro-X

Prime costs		$50,000
Overhead costs:		
Department 1: $1.40 X 4,000 =	$ 5,600	
Department 2: $5.50 X 6,000 =	33,000	38,600
		$88,600
Unit cost $88,600/10,000 units		$8.86

Nitro-Y

Prime costs		$250,000
Overhead costs:		
Department 1: $1.40 X 76,000 =	$106,400	
Department 2: $5.50 X 34,000 =	187,000	293,400
		543,400
Unit cost $543,400/50,000 units		$10.87

Plant-Wide Rate versus Departmental Rates

Using a single, plant-wide overhead rate based on machine hours gave the same overhead application and cost per unit for Nitro-X and Nitro-Y, i.e., $10.53. But this would not be an accurate measurement of the underlying relationship, because Nitro-X made light use of overhead incurring factors while Nitro-Y made heavy use of such services.

To summarize, when products are heterogeneous, receiving uneven attention and effort as they move through various departments, departmental rates are necessary to achieve more accurate product costs.

Problems with Costing Accuracy

The accuracy of the overhead cost assignment can be challenged regardless of whether the plant-wide or departmental rates are used. The main problem with either procedure is the assumption that machine hours or direct labor hours drive or cause all overhead costs.

From Table 2, we know that Nitro-Y--with five times the volume of Nitro-X--uses five times the machine hours and direct labor hours. Thus, if a plant-wide rate is used, Nitro-Y will receive five times more overhead costs. But does it make sense? Is all overhead driven by volume? Use of a single driver--especially volume-related--is not proper.

Examination of the data in Table 2 suggests that a significant portion of overhead costs is not driven or caused by volume. For example, setup costs are probably related to the number of setups and quality control costs to the number of hours of inspection.

Notice that Nitro-Y only has 1.5 times as many setups as the Nitro-X (30/20) and only 1.5 times as many inspection hours (1,200/800). Use of a volume-related cost driver (machine hours or labor hours) and a plant-wide rate assigns five times more overhead to the Nitro-Y than to Nitro-X. For quality control and setup costs, then, Nitro-Y is overcosted, and Nitro-X is undercosted.

The problems worsened when departmental rates were used. Nitro-Y consumes 19 times as many direct labor hours (76,000/4,000) as Nitro-X and 5.7 times as many machine hours (34,000/6,000). Thus, Nitro-Y receives 19 times more overhead from Department 1 and 5.7 times more overhead from Department 2.

As Table 4 shows, with departmental rates the unit cost of Nitro-X decreases to $8.86, and the unit cost of Nitro-Y increases to $10.87. This change emphasizes the failure of volume-based cost drivers to reflect accurately each product's consumption of setup and quality control costs.

Why Volume-Related Cost Drivers Fail

At least two major factors impair the ability of a volume-related cost driver to assign overhead costs accurately: (1) the proportion of nonvolume-related overhead costs to total overhead costs; and (2) the degree of product diversity.

Nonvolume-related Overhead Costs. In our example, there are four overhead activities: quality control, setup, maintenance, and power. Two, maintenance and power, are volume related. Quality control and setup are less dependent on volume. As a result, volume-based cost drivers cannot assign these costs accurately to products.

Using volume-based cost drivers to assign nonvolume-related overhead costs creates distorted product costs. The severity of this distortion depends on what proportion of total overhead costs these nonvolume-related costs represent. For our example, setup costs and quality control costs represent a substantial share—51 percent—of total overhead ($170,000/$332,000). This suggests that some care should be exercised in assigning these costs. If nonvolume-related overhead costs are only a small percentage of total overhead costs, the distortion of product costs would be quite small. In such a case, the use of volume-based cost drivers may be acceptable.

Product Diversity. When products consume overhead activities in different proportions, a firm has product diversity.

To illustrate, the proportion of all overhead activities consumed by both Nitro-X and Nitro-Y is computed and displayed in Table 5. The proportion of each activity consumed by a product is defined as the consumption ratio. As you can see from the table, the consumption ratios for these two products differ from the nonvolume-related categories to the volume-related costs.

TABLE 5
PRODUCT DIVERSITY: PROPORTION OF CONSUMPTION

Overhead Activity	***Nitro-X***	***Nitro-Y***	***Consumption Measure***
Setup	.40(1)	.60(1)	Production runs
Quality control	.40(2)	.60(2)	Inspection hours
Power	.17(3)	.83(3)	Kilowatt hours
Maintenance	.17(4)	.83(4)	Machine hours

(1) 20/50 (Nitro-X) and 30/50 (Nitro-Y)
(2) 800/2,000 (Nitro-X) and 1,200/2,000 (Nitro-Y)
(3) 5,000/30,000 (Nitro-X) and 25,000/30,000 (Nitro-Y)
(4) 10,000/60,000 (Nitro-X) and 50,000/60,000 (Nitro-Y)

Since the nonvolume-related overhead costs are a significant proportion of total overhead and their consumption ratio differs from that of the volume-based cost driver, product costs can be distorted if a volume-based cost driver is used. The solution to this costing problem is to use an *activity-based costing* approach.

ACTIVITY-BASED PRODUCT COSTING

An activity-based cost system is one which first traces costs to activities and then to products. Traditional product costing also involves two stages, but in the first stage costs are traced to departments, not to activities. In both traditional and activity-based costing, the second stage consists of tracing costs to the product.

The principal difference between the two methods is the number of cost drivers used. Activity-based costing uses a much larger number of cost drivers than the one or two volume-based cost drivers typical in a conventional system. In fact, the approach separates overhead costs into overhead cost pools, where each cost pool is associated with a different cost driver. Then a predetermined overhead rate is computed for each cost pool and each cost driver. In consequence, this method has enhanced accuracy.

Activity-based costing (ABC) is not an alternative costing system to job costing or process costing. It focuses on activities as the principal cost objects. ABC is a method of assigning costs to goods and services that assume all costs are caused by the activities used to produce those goods and services. This method provides more insight into the causes of costs than conventional costing methods. Conventional costing methods divide the total costs by the number of units to compute a unit cost. In contrast, activity-based costing starts with the detailed activities required to produce a product or service and computes a product's cost using the following *four* steps:

1. Identify the activities that consume resources, and assign costs to those activities. Inspection would be an activity, for example.

2. Identify the cost driver(s) associated with each activity or group of activities, known as a cost *pool*. A cost driver is a factor that causes, or "drives," an activity's costs. The number of inspections would be a cost driver. So could the number of times a new drawing is needed because a product has been redesigned.

3. Calculate an applied rate for each activity pool. The pool rate could be the cost per purchase order.

4. Assign costs to products by multiplying the cost pool rate by the number of cost driver units consumed by the product. For example, the cost per inspection *times* the number of inspections required for Product X for the month of March would measure the cost of inspection activity for Product X for March.

Note: ABC is also applicable to service, merchandising, and nonprofit sectors as well as manufacturing companies.

First-Stage Procedure

In the first stage of activity-based costing, overhead costs are divided into homogeneous cost pools. A *homogeneous* cost pool is a collection of overhead costs for which cost variations can be explained by a single cost driver. Overhead activities are homogeneous whenever they have the same consumption ratios for all products.

Once a cost pool is defined, the cost per unit of the cost driver is computed for that pool. This is referred to as the *pool rate*. Computation of the pool rate completes the first stage. Thus, the first stage produces two outcomes: (1) a set of homogeneous cost pools and (2) a pool rate.

For example, in Table 5, quality control costs and setup costs can be combined into one homogeneous cost pool and maintenance and power costs into a second. For the first cost pool, the number of production runs or inspection hours could be the cost driver. Since the two cost drivers are perfectly correlated, they will assign the same amount of overhead to both products. For the second pool, machine hours or kilowatt hours could be selected as the cost driver.

Assume for the purpose of illustration that the number of production runs and machine hours are the cost drivers chosen. Using data from Table 2, the first-stage outcomes are illustrated in Table 6.

TABLE 6
ACTIVITY-BASED COSTING: FIRST-STAGE PROCEDURE

Pool 1:	
Setup costs	$96,000
Quality control costs	74,000
Total costs	$170,000
Production runs	50
Pool rate (Cost per run) $170,000/50	$3,400
Pool 2:	
Power cost	$84,000
Maintenance	78,000
Total costs	$162,000
Machine hours	60,000
Pool rate (Cost per machine hour) $162,000/60,000	$2.70

Second-Stage Procedure

In the second stage, the costs of each overhead pool are traced to products. This is done using the pool rate computed in the first stage and the measure of the amount of resources consumed by each product. This measure is simply the quantity of the cost driver used by each product. In our example, that would be the number of production runs and machine hours used by each product. Thus, the overhead assigned from each cost pool to each product is computed as follows:

Applied overhead = Pool rate x Cost driver units used

To illustrate, consider the assignment of costs from the first overhead pool to Nitro-X. From Table 6, the rate for this pool is $3,400 per production run. From Table 2, Nitro-X uses 20 production runs. Thus, the overhead assigned from the first cost pool is $68,000 ($3,400 X 20 runs). Similar assignments would be made for the other cost pool and for the other product (for both cost pools).

The total overhead cost per unit of product is obtained by first tracing the overhead costs from the pools to the individual products. This total is then divided by the number of units produced. The result is the unit overhead cost. Adding the per-unit overhead cost to the per-unit prime cost yields the manufacturing cost per unit. In Table 7, the manufacturing cost per unit is computed using activity-based costing.

Comparison of Product Costs

In Table 8, the unit cost from activity-based costing is compared with the unit costs produced by conventional costing using either a plant-wide or departmental rate. This comparison clearly illustrates the effects of using only volume-based cost drivers to assign overhead costs. The activity-based cost reflects the correct pattern of overhead consumption and is, therefore, the most accurate of the three costs shown in Table 8. Activity-based product costing reveals that the conventional method undercosts the Nitro-X significantly--by at least 37.7 percent = ($14.50 - 10.53)/$10.53) and overcosts the Nitro-Y by at least 8.1 percent = ($10.53 - $9.74)/$9.74.

Note: Using only volume-based cost drivers can lead to one product subsidizing another. This subsidy could create the appearance that one group of products is highly profitable and adversely impact the pricing and competitiveness of another group of products. In a highly competitive environment, accurate cost information is critical for sound planning and decision making.

The Choice of Cost Drivers

At least two major factors should be considered in selecting cost drivers: (1) the cost of measurement and (2) the degree of correlation between the cost driver and the actual consumption of overhead.

The Cost of Measurement. In an activity-based cost system, a large number of cost drivers can be selected and used. However, it is preferable to select cost drivers that use information that is readily available. Information that is not available in the existing system must be produced, which will increase the cost of the firm's information system. A homogeneous cost pool could offer a number of possible cost drivers. For this situation, any cost driver that can be used with existing information should be chosen. This choice minimizes the costs of measurement.

In our example, for instance, quality control costs and setup costs were placed in the same cost pool, giving the choice of using either inspection hours or number of production runs as the cost driver. If the quantities of both cost drivers used by the two products are already being produced by the company's information system, then which is chosen is unimportant. Assume, however, that inspection hours by product are not tracked, but data for production runs are available. In this case, production runs should be chosen as the cost driver, avoiding the need to produce any additional information.

TABLE 7
ACTIVITY-BASED COSTING: SECOND-STAGE PROCEDURE
UNIT COSTS

Nitro-X

Prime costs	$50,000
Overhead:	
Pool 1: $3,400 X 20	$68,000
Pool 2: $2.70 X 10,000	27,000
Total overhead costs	$95,000
Total manufacturing costs	$145,000
Units produced	10,000
Unit cost	$14.50

Nitro-Y

Prime costs	$250,000
Overhead:	
Pool 1: $3,400 X 30	$102,000
Pool 2: $2.70 X 50,000	135,000
Total overhead costs	$237,000
Total manufacturing costs	$487,000
Units produced	50,000
Unit cost	$9.74

TABLE 8
COMPARISON OF UNIT COSTS

	Nitro - X	***Nitro - Y***	***Source***
Traditional:			
Plant – wide rate	10.53	10.53	Table 3
Department rates	8.86	10.87	Table 4
Activity- based costing	$14.50	$9.74	Table 7

Indirect Measures and the Degree of Correlation. The existing information structure can be exploited in another way to minimize the costs of obtaining cost driver quantities. It is sometimes possible to replace a cost driver that directly measures the consumption of an activity with a cost driver that indirectly measures that consumption. For example, inspection hours could be replaced by the actual number of inspections associated with each product; this number is more likely to be known. This replacement only works, of course, if hours used per inspection are reasonably stable for each product. *Regression analysis*, which will be covered in Chapter 6 (Analysis of Cost Behavior), can be utilized to determine the degree of correlation. A list of potential cost drivers is given in Table 9.

Cost drivers that indirectly measure the consumption of an activity usually measure the number of transactions associated with that activity. It is possible to replace a cost driver that directly measures consumption with one that only indirectly measures it without loss of accuracy provided that the quantities of activity consumed per transaction are stable for each product. In such a case, the indirect cost driver has a high correlation and can be used.

TABLE 9
COST DRIVERS

MANFACTURING:	
Machine hour	Miles driven
Direct labor hour or dollars	Computer time
Number of setups	Square footage
Weight of materials handled	Number of vendors
Number of units reworked	Asset value
Number of orders placed	Number of labor transactions
Number of orders received	Number of units scrapped
Number of inspections	Number of parts
Number of materials handling operations	Replacement cost
Number of orders shipped	Design time
Hours of testing time	
NON-MANUFACTURING:	
Number of hospital beds occupied	
Number of surgeries	
Number of take-offs and landings for an airline	
Flight hours	
Number of rooms occupied in a hotel	

TABLE 10
COST SYSTEM COMPARISON

	Traditional	ABC
Cost pools:	One or a limited Number	Many to reflect different Activated
Applied rate:	Volume-based, Financial	Activity-based, Nonfinancial
Suited for:	Labor-intensive, Low-overhead companies	Capital-intensive, Product-diverse, High-overhead companies
Benefits:	Simple, Inexpensive	Accurate product costing, Possible elimination of Nonvalue-added activities

EXAMPLE 2

We will examine the effects of three alternative product-costing systems at Sigma Controls Corporation, which manufactures two types of sophisticated control valves used in the food processing industry. Valve A has been Sigma's main product for 15 years. It is used to control the flow of milk in various food processing operations, such as the productions of cookies. Valve B, a more recently introduced product, is a specialty valve used to control the follow of thicker foods such as jelly and applesauce. The basic data for the illustration follow:

	Valve A	*Valve B*
Annual production and sales	30,000 units	5,000 units
Direct material	$140	$140
Direct labor:		
Machining Department	30 (1.5 hr. at $20)	30 (1.5 hr. at $20)
Assembly Department	30 (1.5 hr. at $20)	30 (1.5 hr. at $20)
Total prime costs	$200	$200
Machine time in Machiing Department	1 hr.	3 hrs.
Budgeted overhead costs:		
Machining Department	$630,000	
Assembly Department	$315,000	
Total	$945,000	

Now we will compute the applied overhead cost per valve under three alternative product-costing systems.

Plantwide Overhead Rate Using a single, plantwide overhead rate based on direct-labor hours (DLH), each product is assigned $27 of overhead per unit.

Adding the $200 of prime costs for each valve, we have product costs of $227 per unit for each type of valve.

	Valve A	*Valve B*
Applied overhead per unit*	$27 (3 DLH at $9 per DLH)	$27 (3 DLH at $9 per DLH)

*Total budgeted DLH = (30,000 units of A) (3 DLH per unit) + (5,000 units of B) (3 DLH per unit) = 105,000 DLH

$$\text{Predetermined overhead rate} = \frac{\text{Total budgeted overhead}}{\text{Total budgeted DLH}} = \frac{\$945{,}000}{105{,}000} = \$9 \text{ per DLH}$$

Departmental Overhead Rates Now suppose we use departmental overhead rates. The Machining Department rate is based on machine hours (MH), whereas the Assembly Department rate is based on direct-labor hours (DLH). This approach yields assigned overhead costs of $23 per unit of valve A and $51 per unit of valve B.

	Valve A	*Valve B*
Applied overhead per unit:		
Machining Department*	$14 (1 MH at $14 per MH)	$42 (3 MH at $14 per MH)
Assembly Department**	9 (1.5 DLH at $6 per DLH)	9 (1.5 DLH at $6 per DLH)
Total	$23	$51

*Total budgeted MH = (30,000 units of A) (1 MH per unit) + (5,000 units of B) (3 MH per unit) = 45,000 MH

$$\text{Machining Department overhead rate} = \frac{\text{Machining Department overhead}}{\text{Budgeteed MH}} = \frac{\$630{,}000}{45{,}000} = \$14 \text{ per MH}$$

**Total budgeted DLH in Assembly Department= (30,000 units of A) (1.5 DLH) + (5,000 units of B) (1.5 DLH) = 52,500 DLH

$$\text{Assembly Department overhead rate} = \frac{\text{Assembly Department overhead}}{\text{Budgeteed MH}} = \frac{\$315{,}000}{52{,}500} = \$6 \text{ per DLH}$$

Adding the $200 of prime costs for each valve, we have product costs of $223 for each unit of valve A and $251 for each of valve B. Valve A, which spends considerably less time in the more costly Machining Department than valve B, is now assigned a lower product cost than it was when a plantwide overhead rate was used. In contrast, valve B's assigned product cost has increased.

Activity-Based Costing (ABC) Finally, let's see what happens to the assigned overhead costs under activity-based costing. Suppose Sigma's accountants have established the following activity cost pools and cost drivers in stage one of the ABC method.

Activity	Activity Cost Cost	Quantity of Cost Driver	Cost per Unit of Cost Driver
Machine setups	$6,000	120 setups	$50 per setup
Engineering and design	210,000	7,000 engineering hrs.	$30 per engineering hr.
Material handling	22,000	220,000 lb. Of material	$.10 per lb.
Quality control	32,000	800 inspections	$40 per inspection
Machinery-related costs	675,000	45,000 machine hrs.	$15 per machine hr.
Total	$945,000		

In stage two of the ABC method, Sigma's accountants estimated how much of each cost driver is consumed by each *product line*. The ABC system then assigned overhead costs of $16.80 per unit of valve A and $88.20 per unit of valve B as follows:

	Valve A		Valve B	
Applied overhead per product line:				
Setup ($50 per setup)	$1,000	(20 setups)	$5,000	(100 setups)
Engineering and design ($30 per hr.)	30,000	(1,000 hrs.)	180,000	(6,000 hr.)
Material handling ($.10 per lb.)	17,000	(170,000 lb.)	5,000	(50,000 lb.)
Quality control ($40 per inspection)	6,000	(150 setups)	26,000	(650 inspections)
Machinery-related costs ($15 per MH)	450,000	(30,000 MH)	225,000	(15,000 MH)
Total	$504,000		$441,000	
Applied overhead per unit:	$16.80	$\left(\frac{\$504{,}000}{30{,}000 \text{ units}}\right)$	$88.20	$\left(\frac{\$441{,}000}{5{,}000 \text{ units}}\right)$

Total applied overhead = $504,000 + $441,000 = $945,000

Adding the $200 of prime costs for each valve, we have product costs of $216.80 for each unit of valve A and $288.20 for each unit of valve B. Valve A, a high-valve and relatively simple product, is considerably less expensive to produce than valve B, a low-volume and relatively complex product.
To summarize,

The following table compares the total reported product costs of each product under the three alternative product-costing systems.

	Valve A	*Valve B*
Plantwide overhead rate	$227.00	$227.00
Departmental overhead rates	$223.00	$251.00
Activity-based costing	$216.80	$288.20

Activity-based costing yields the most accurate product cost for each valve. Notice that both the plantwide and departmental overhead costing systems significantly overcost the high-volume and relatively simple valve A, and undercost the low-volume and complex valve B.

EXAMPLE 3

Global Metals, Inc. has established the following overhead cost pools and cost drivers for their product:

Overhead Cost Pool	***Budgeted Overhead Cost***	***Cost Driver***	***Predicted Level for Cost Driver***	***Predetermined Overhead Rate***
Machine Set-ups	$100,000	Number of set-ups	100	$1,000 per set-up
Material Handling	100,000	Weight of raw material	50,000 pounds	$2.00 per pound
Waste Control	50,000	Weight of hazardous chemical used	10,000 pounds	$5.00 per pound
Inspection	75,000	Number of inspections	1,000	$75 per inspections
Other Overhead Costs	$200,000	Machine Hours	20,000	$10 per MH
	$525,000			

Job No. 107 consists of 2,000 special purpose machine tools with the following requirements:

Machine set-ups	2 set-ups
Raw material required	10,000 pounds
Waste material required	2,000 pounds
Inspections	10 inspections
Machine hours	500 machine hours

The overhead assigned to Job No. 107 is computed below:

Overhead Cost Pool	***Predetermined Overhead Rate***	***Level of Cost Driver***	***Assigned Overhead Cost***
Machine set-ups	$1,000 per set-up	2 set-ups	$2,000
Material handling	$2.00 per pound	10,000 pounds	20,000
Waste control	$5.00 per pound	2,000 pounds	10,000
Inspection	$75 per inspection	10 inspections	750
Other overhead cost	$10 per machine hour	500 machine hour	5,000
Total			$37,750

The total overhead cost assigned to Job No. 107 is **$37,750,** or $18.88 per tool ($37,750/2,000).

Compare this with the overhead cost that is assigned to the job if the firm uses a single predetermined overhead rate based on machine hours:

Total budgeted overhead cost / Total predicted machine hours

= $525,000 / 20,000

= $26.25 per machine hour

Under this approach, the total overhead cost assigned to Job No. 107 is **$13,125** ($26.25 per machine hour x 500 machine hours). This is only $6.56 per tool ($13,125/2,000), which is about 1/3 of the overhead cost per tool computed when multiple cost drivers are used.

To summarize,

	ABC	***Traditional***
Total factory overhead assigned	$37,750	$13,125
Per tool	$18.88	$6.56

The reason for this wide discrepancy is that these special purpose tools require a relatively large number of machine set-ups, a sizable amount of waste materials, and several inspections. Thus, they are relatively costly in terms of driving overhead costs. Use of a single predetermined overhead rate obscures that fact.

Inaccurately calculating the overhead cost per unit to the extent illustrated above can have serious adverse consequences for the firm. For example, it can lead to poor decisions about pricing, product mix, or contract bidding.

Note: The cost accountant needs to weigh carefully such considerations in designing a product costing system. A costing system using multiple cost drivers is more costly to implement and use, but it may save millions through improved decisions.

Note: An ABC approach is expensive to implement and keep. Companies considering ABC should perform a cost-benefit test. The benefits are most significant when a company has

(1) different products or services that make different demands on resources
(2) stiff competition where knowledge of costs and cost control is critical.

ABC forces management to think in terms of simplifying operations (activities). Once activities that are consumed by a product are identified, the process can be evaluated with a view to cut costs.

COST ACCOUNTING IN ACTION— The Activity-Based Costing Portal (http://www.offtech.com.au/abc/Home.asp) This site offers a free ABC magazine, links to articles, ABC software, and a forum for discussion of ABC related topics. A special feature allows students and businesses to submit questions on ABC.
Articles recently featured on the site include:
•*A Procedure for Smooth Implementation* of *Activity Based Costing in Small Companies*
•*The Association Between Activity-Based Costing and Improvement in Financial Performance*
•*Using Activity-Based Costing to Manage More Effectively*
•*Activity-Based Costing Approach to Equipment Selection Problem for Flexible Manufacturing Systems*
•*Quality, Cost, and Value-Added in Comprehensive Institutions of Higher Education*

CASB NO.418 -- ALLOCATION OF INDIRECT COST POOLS

Cost Accounting Standard No.418 provides criteria for the accumulation of indirect costs in cost pools, such as those established for service departments, and offer guidance for the allocation bases. Indirect costs would be accumulated into homogeneous indirect cost pools. An indirect cost pool is homogeneous if all the activities included in the pool have a similar relationship to cost objectives or if the resulting allocation is substantially the same as it could be if the costs of the activities were allocated separately.

Pooled costs would be portioned according to the beneficial or causal relationship of the pooled costs to cost objectives. Allocation would be based on any of the following, in order of preference:

- A resource consumption measure
- An output measure
- A surrogate representative of resources consumed

• A measure representative of the entire activity being managed

A *resource consumption measure*, such as labor hours, machine hours, or kilowatt-hours, is used where there is a direct and definite relationship between the activities and the measure of resources consumption can be used. *Output measure* in units of end product is to be used when resource consumption measures are unavailable or not ascertainable. Output measure may not reflect the proportional resources consumption if the consumption level varies among the units produced.

When the difference is material, the measure shall be modified or more than one measure shall be used. A *surrogate*, such as the number of employees served by a personnel department, or the number of square meters served by the building and grounds department, is used to measure the resources consumed if neither resources consumed nor output can be measured. Surrogates generally measure the activity of the cost objective receiving the service and shall vary according to services received.

A measure representative of the entire activity being managed shall be used if none of the aforementioned methods is feasible. Pools that cannot be measured by beneficial or causal relationships (for example, overall management activities) are to be grouped in relation to the activities managed. The base should be representative of its entire activity. Where there is a simultaneous use of a service center, costs are prorated.

Representative preestablished rates, based on either forecasted actual or standard costs, may be used in allocating an indirect cost pool and may be reviewed at least annually and revised as necessary. If significant variances exist, an adjustment should be made using the revised rates.

USING ACTIVITY-BASED COSTING TO MAKE MARKETING DECISIONS

Marketing cost analysis provides relevant data for managerial decisions to add or drop territories and products. Applying principles of activity-based costing to marketing activities helps marketing managers make decisions about product line or territory profitability. For example, suppose the Nike shoe company considers opening a territory in Russia. The first step is to determine what activities would be required to market shoes in Russia. These activities would include selling, warehousing, order filling, providing credit and collecting on accounts receivable, and shipping, in addition to advertising and promotion. The second step is to identify measures of the activities. Some examples of activity measures are shown in Table 11. The next step is to estimate the cost of each activity. Finally, management would estimate the number of activities required to open the sales territory in Russia which, multiplied by the cost per activity, would provide an estimate of the cost of marketing in the new territory.

TABLE 11
ACTIVITY COST DRIVERS

Activity	*Measures*
Selling	Number of sales calls Number of orders obtained Volume of sales
Warehousing	Number of items stored Volume of items stored
Credit and collection	Number of customer orders Dollar amount of customer orders on account

SOURCE: Ronald Lewis, "Activity-Based Costing for Marketing," *Management Accounting*, November 1991, pp. 33-38.

ACTIVITY-BASED MANAGEMENT

Activity-based management (ABM) is one of the most important ways to be competitive. It is a systemwide, integrated approach that focuses management's attention on activities with the goal of improving customer value, reducing costs, and the resulting profit. The basic premise of ABM is: *Products consume activities; activities consume resources.* To be competitive, you must know both (1) the activities that go into manufacturing the products or providing the services, and (2) the cost of those activities. To cut down a product's costs, you will likely have to change the activities the product consumes. An attitude such as " I want across-the-board-cuts—everyone reduce cost by 10%" rarely obtains the desired results.

In order to achieve desired cost reductions, you must first identify the activities that a product or service consumes. Then you must figure out how to rework those activities to improve productivity and efficiency. *Process value analysis* is used to try to determine why activities are performed and how well they are performed. *Activity-based costing*, discussed in this chapter, is a tool used in activity-based management.

Process value analysis

Process value analysis is the process of identifying, describing, and evaluating the activities a company performs. It produces the following four outcomes:

1. What activities are done.
2. How many people perform the activities.
3. The time and resources required to perform the activities.
4. An assessment of the value of the activities to the company, including a recommendation to select and keep only those that add value.

Understanding What Causes Costs

Effective cost control requires managers to understand how producing a product requires activities and how activities, in turn, generate costs. Consider the activities of a manufacturer facing a financial crisis. In a system of managing by the members, each department is told to reduce costs in an amount equal to its share of the budget cut. The usual response by department heads is to reduce the number of people and supplies, as these are the only cost items that they can control in the short run. Asking everyone to work harder produces only temporary gains, however, as the pace cannot be sustained in the long run.

Under ABM, the manufacturer reduces costs by studying what activities it conducts and develops plans to eliminate nonvalue-added activities and to improve the efficiency of value-added activities. Eliminating activities that do not create customer value is a very effective way to cut costs. For example, spending $100 to train all employees to avoid common mistakes will repay itself many times over by reducing customer ill will caused by those mistakes.

Value Added and Nonvalue – Added Activities

A *value-added activity* is an activity that increases the product's service to the customer. For instance, purchasing the raw materials to make a product is a value-added activity. Without the purchase of raw materials, the organization would be unable to make the product. Sanding and varnishing a wooden chair are value-added activities because customers don't want splinters. Value-added activities are evaluated by how they contribute to the final product's service, quality, and cost.

Good management involves finding and, if possible, eliminating nonvalue-added activities. *Nonvalue-added activities* are activities that when eliminated reduce costs without reducing the product’s potential to the customer. In many organizations poor facility layout may require the work in process to be moved around or temporarily stored during production. For example, a Midwest steel company that we studied had more than 100 miles of railroad track to move things back and forth in a poorly designed facility. Moving work around a factory, an office, or a store is unlikely to add value for the customer. Waiting, inspecting, and storing are other examples of nonvalue-added activities.

Organizations must change the process that makes nonvalue-added activities necessary. Elimination of nonvalue-added activities requires organizations to improve the process so that the activities are no longer required. Organizations strive to reduce or eliminate nonvalue-added activities because, by doing so, they permanently reduce the costs they must incur to produce goods or services without affecting the value to the customer.

Although managers should pay particular attention to nonvalue-added activities, they should also carefully evaluate the need for value-added activities. For example, in wine production, classifying storage as a value-added activity assumes the only way to make good-tasting wine is to allow it to age in storage. Think of the advantage that someone could have if he discovered a way to produce wine that tastes as good as *conventionally* aged wine but does not *require* long storage periods.

Activity Drivers and Categories

Activity output is measured by activity drivers. An activity driver is a factor (activity) that causes (drives) costs. We can simply identify activity output measures by classifying activities into four general categories: (1) unit level, (2) batch level (3) product level, and (4) facility level. Classifying activities into these general categories is useful because the costs of activities associated with the different levels respond to different types of activity drivers. Table 12 describes what they perform, examples, output measures, and examples of possible cost drivers.

The Value Chain of the Business Functions

The value chain concept of the business functions is used throughout the course to demonstrate how to use cost/managerial accounting to add value to organizations (see Figure 1). The *value chain* describes the linked set of activities that increase tine usefulness (or value) of the products or services of an organization (value-added activities). Activities are evaluated by how they contribute to the final product's service, quality, and cost. In general, the business functions include the following:

- *Research and development*: the generation and development of ideas related to new products, services, or processes.
- *Design:* the detailed planning and engineering of products, services, or processes.
- *Production:* the aggregation and assembly of resources to produce a product or deliver a service.
- *Marketing:* the process that (a) informs potential customers about the attributes of products or services and (b) leads to the purchase of' those products or services.
- *Distribution:* the mechanism established to deliver products or services to customers.
- *Customer service:* the product or service support activities provided to customers.

A **strategy and administration** function spans all the business activities described. Human resource management, tax planning, legal matters, and the like, for example, potentially affect every step of the value chain. Cost and managerial accounting is a major means of helping managers (a) to run each of the business functions and (b) to coordinate their activities within the framework of the entire organization.

Strategic Cost Analysis

Companies can identify strategic advantages in the marketplace by analyzing the value chain and the information about the costs of activities. A company that eliminates nonvalue-added activities reduces costs without reducing the value of the product to customers. With reduced costs, the company can reduce the price it charges customers, thus giving the company a cost advantage over its competitors. Or the company can use the resources saved from eliminating nonvalue-added activities to provide greater service to customers. *Strategic cost analysis* is the use of cost data to develop and identify superior strategies that will produce a sustainable competitive advantage. The idea here is simple. Look for activities that are not on the value chain. If' the company can safely eliminate nonvalue-added activities, then it should do so. By identifying and cutting them, you will save the company money and make it more competitive.

Global Strategies

Another approach to gaining a cost advantage is to identify where on the value chain your company has a strategic advantage. Many computer software companies, for example, are looking at foreign markets as a way to capitalize on their investment in research and development. The reservoir of intellectual capital gives these firms an advantage over local competitors who have not yet developed this expertise. These competitors would face research and development costs already incurred by established companies, making it difficult for the newcomers to charge competitive prices and still make a profit.

CHAPTER SUMMARY

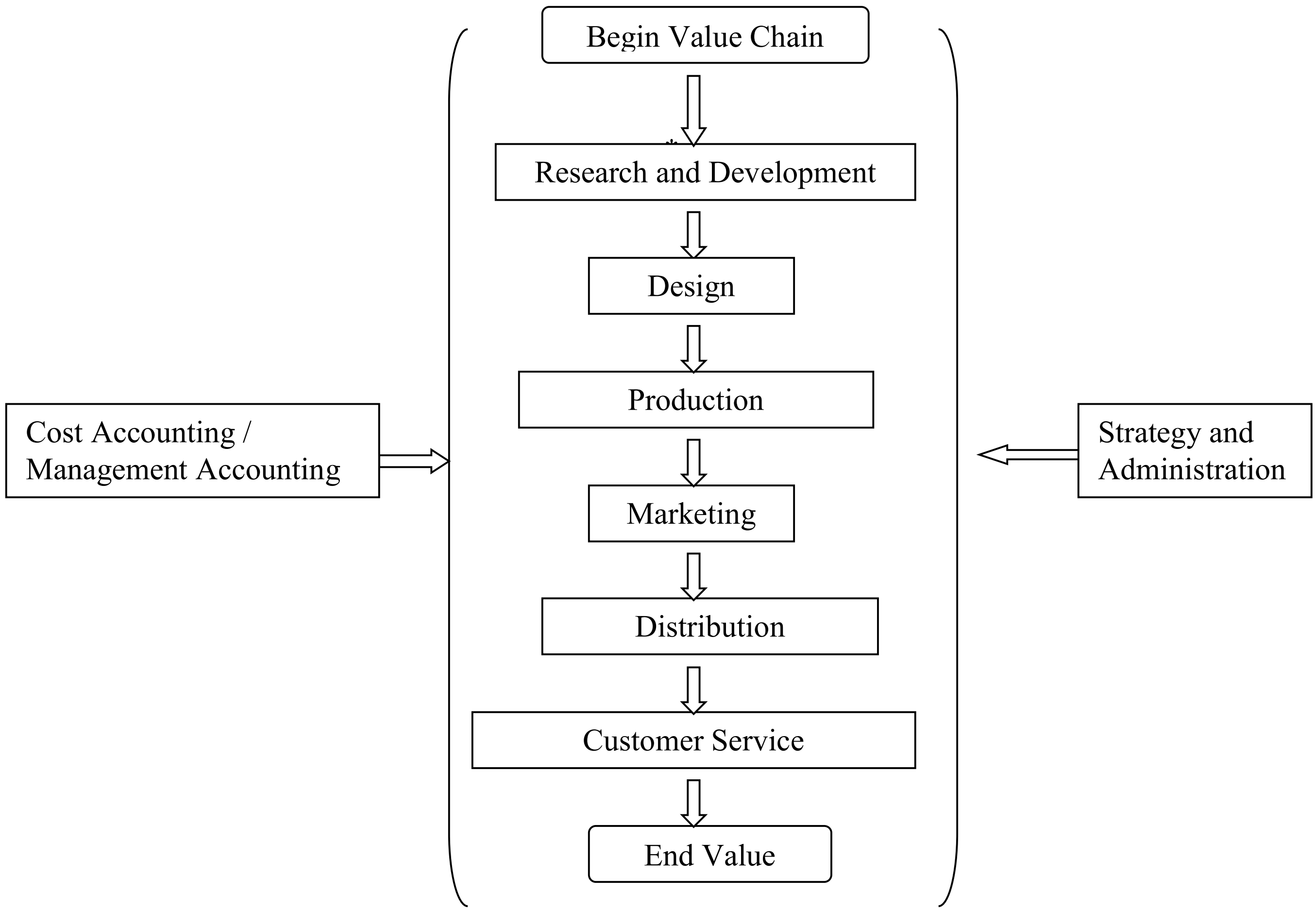
The chapter discussed in detail how activity costing provides more accurate product cost figures for product costing and pricing, using multiple overhead cost pools and cost drivers. Conventional cost systems are not able to assign the costs of nonvolume-related overhead activities accurately. For this reason, assigning overhead using only volume-based drivers or a single driver can distort product costs.

Two examples were provided to illustrate the use of the ABC system *versus* the traditional system using a single driver such as machine hours or direct labor hours. Activity-based costing may provide more accurate information about product costs. It helps managers make better decisions about product design, pricing, marketing, and mix, and encourages continual operating improvements. Activity-based management (ABM), of which ABC is a tool, was discussed.

ACTIVITY CATEGORIES AND DRIVERS

	Unit-Level Activities	***Batch-Level Activities***	***Product-Level (Product- and Customer-Sustaining) Activities***	***Facility-Level (Capacity-Sustaining) Activities***
Activities	Performed each time a unit is produced	Performed each time a batch is produced	Performed as needed to support a product	Sustain a factory's general manufacturing process
Examples:	Direct materials, direct labor, assembly, energy to run machines	Quality inspections, machine setups, production scheduling, material handling	Engineering changes, maintenance of equipment, customer records and files, marketing the product	Plant management, plant security, landscaping, maintaining grounds, heating and lighting, property taxes, rent, plant depreciation
Output measures:	Unit-level drivers	Batch-level drivers	Product-level drivers	Difficult to define
Examples:	Units of product, direct labor hours, machine hours	Number of batches, number of production orders, inspection hours	Number of products, number of changing orders	Plant size (square feet), number of security personnel

FIGURE 1
THE VALUE CHAIN AND COST/MANAGEMENT ACCOUNTING



CHAPTER 5
COST-VOLUME-PROFIT ANALYSIS

Cost-volume-profit (CVP) analysis, together with cost behavior information, helps cost/managerial accountants perform many useful analyses. CVP analysis deals with how profit and costs change with a change in volume. More specifically, it looks at the effects on profits of changes in such factors as variable costs, fixed costs, selling prices, volume, and mix of products sold. By studying the relationships of costs, sales, and net income, management is better able to cope with many planning decisions.

Break-even analysis, a branch of CVP analysis, determines the break-even sales. Break-even point--the financial crossover point when revenues exactly match costs--does not show up in corporate earnings reports, but managerial accountants find it an extremely useful measurement in a variety of ways.

After studying the material in this chapter, you will be able to

- List and define various contribution margin concepts.
- Compute the sales necessary to break even or to achieve a target income.
- Prepare break-even and profit-volume charts.
- Perform a variety of "what-if" analysis using the contribution approach.
- Define and explain margin of safety.
- Discuss the impact of a change in sales mix on profitability.

QUESTIONS ANSWERED BY CVP ANALYSIS

CVP analysis tries to answer the following questions:

(a) What sales volume is required to break even?
(b) What sales volume is necessary to earn a desired profit?
(c) What profit can be expected on a given sales volume?
(d) How would changes in selling price, variable costs, fixed costs, and output affect profits?
(e) How would a change in the mix of products sold affect the break-even and target income volume and profit potential?

Contribution Margin (CM)

For accurate CVP analysis, a distinction must be made between costs as being either variable or fixed. Mixed costs must be separated into their variable and fixed components.

In order to compute the break-even point and perform various CVP analyses, note the following important concepts.

CONTRIBUTION MARGIN (CM). The contribution margin is the excess of sales (S) over the variable costs (VC) of the product or service. It is the amount of money available to cover fixed costs (FC) and to generate profit. Symbolically,

$$\text{CM} = \text{S} - \text{VC}.$$

UNIT CM. The unit CM is the excess of the unit selling price (p) less the unit variable cost (v). Symbolically,

$$\text{Unit CM} = \text{p} - \text{v}.$$

CM RATIO. The CM ratio is the contribution margin as a percentage of sales, i.e.,

$$\text{CM Ratio} = \frac{CM}{S} = \frac{(S - VC)}{S} = 1 - \frac{VC}{S}$$

The CM ratio can also be computed using per-unit data as follows:

$$\text{CM Ratio} = \frac{Unit\,CM}{p} = \frac{(p - v)}{p} = 1 - \frac{v}{p}$$

Note that the CM ratio is 1 minus the variable cost ratio. For example, if variable costs are 40% of sales, then the variable cost ratio is 40% and the CM ratio is 60%

EXAMPLE 1

To illustrate the various concepts of CM, consider the following data for ABC Toy Store:

	Total	Per Unit	Percentage
Sales (1,500 units)	$37,500	$25	100%
Less: Variable costs	15,000	10	40
Contribution margin	$22,500	$15	60%
Less: Fixed costs	15,000		
Net income	$7,500		

From the data listed above, CM, unit CM, and the CM ratio are computed as:

CM = S - VC = $37,500 - $15,000 = $22,500

Unit CM = p - v = $25 - $10 = $15

CM Ratio = CM / S = $22,500 / $37,500 = 1 - ($15,000 / $37,500)
= 1 - 0.4 = 0.6 = 60%
or = Unit CM / p = $15 / $25 = 0.6 = 60%

BREAK-EVEN ANALYSIS

The break-even point represents the level of sales revenue that equals the total of the variable and fixed costs for a given volume of output at a particular capacity use rate. For example, you might want to ask the break-even occupancy rate (or vacancy rate) for a hotel or the break-even load rate for an airliner.

Generally, the lower the break-even point, the higher the profit and the less the operating risk, other things being equal. The break-even point also provides managerial accountants with insights into profit planning.

It can be computed in three different ways: the equation approach, contribution approach, and graphical approach. The *equation approach* is based on the cost-volume-profit equation which shows the relationships among sales, variable and fixed costs, and net income.

$$S = VC + FC + \text{Net Income}$$

At the break-even volume, S = VC + FC + 0. Defining x = volume in *units*, the above relationship can be written in terms of x:

$$px = vx + FC$$

$$(p\text{-}v)x = FC$$

Solving for x yields the following formula for break-even sales volume:

$$x = \frac{FC}{(p - v)} = \frac{\text{Fixed Costs}}{\text{Unit CM}}$$

Or

$$\text{Break-even point in dollars (S)} = \frac{\text{Fixed Costs}}{\text{CM Ratio}}$$

Note: The sales revenue needed to breakeven is that point at which the company covers all costs but generates no income.

$$S = VC + FC + 0$$

$$S = (VC/S)S + FC$$

$$(1 - VC/S)S = FC$$

$$S = \frac{FC}{(1 - VC/S)} = \frac{\text{Fixed Costs}}{(1 - \text{Variable Cost Ratio})} = \frac{\text{Fixed Costs}}{\text{CM Ratio}}$$

EXAMPLE 2

Using the same data given in Example 1, where unit CM = \$25 - \$10 = \$15 and CM ratio = 60%, we get:

Break-even point in units = \$15,000/\$15 = 1,000 units

Break-even point in dollars = 1,000 units X \$25 = \$25,000

Or, alternatively, \$15,000/0.6 = \$25,000

GRAPHICAL APPROACH IN A SPREADSHEET FORMAT

The graphical approach to obtaining the break-even point is based on the so-called *break-even (B-E) chart* as shown in Figure 1. Sales revenue, variable costs, and fixed costs are plotted on the vertical axis while volume, x, is plotted on the horizontal axis. The break-even point is the point where the total sales revenue line intersects the total cost line. The chart can also effectively report profit potentials over a wide range of activity and therefore be used as a tool for discussion and presentation.

The *profit-volume (P-V) chart,* as shown in Figure 2, focuses directly on how profits vary with changes in volume. Profits are plotted on the vertical axis while units of output are shown on the horizontal axis. The P-V chart provides a quick condensed comparison of how alternatives on pricing, variable costs, or fixed costs may affect net income as volume changes. The P-V chart can be easily constructed from the B-E chart. Note that the slope of the chart is the unit CM.

Determination of Target Income Volume

Besides determining the break-even point, CVP analysis determines the sales required to attain a particular income level or target net income. There are two ways in which target net income can be expressed:

Case 1. As a specific dollar amount
Case 2. As a percentage of sales

Case 1

As a specific dollar amount, the formula is:

$$\text{Target income sales volume} = \frac{\text{Fixed Costs} + \text{Target Income}}{\text{Unit CM}}$$

Case 2

Specifying target income as a percentage of sales, the cost-volume equation is

$$px = vx + FC + \%(px)$$

Solving this for x yields:

$$\frac{FC}{p - v - \%(p)}$$

In words.

$$\text{Target income sales volume} = \frac{\text{Fixed Costs}}{\text{Unit CM} - (\%\text{ of Unit Sales Price})}$$

EXAMPLE 3

Using the same data given in Example 1, assume that ABC Toy Store wishes to attain:

Case 1. A target income of $15,000 before tax
Case 2. A target income of 20% of sales

In Case 1, the target income volume would be:

($15,000 + $15,000) / ($25 - $10) = $30,000 / $15 = 2,000 Units

In Case 2, the target income volume required is:

$15,000/[($25 - $10 – (20%)($25)] = $15,000/($15 - $5) = 1,500 Units

Impact of Income Taxes

If target income (expressed as a specific dollar amount) is given on an after-tax basis, an adjustment is necessary before we use the previous formula. The reason is that the profit target is expressed in before-tax terms. Therefore, the after-tax target income must be first converted to a before-tax target, as follows:

$$\text{Before-tax target income} = \frac{\text{After - tax Target Income}}{(1 - \text{Tax Rate})}$$

EXAMPLE 4

Assume in Example 1 that ABC Toy Store wants to achieve an after-tax income of \$6,000. The tax rate is 40 percent. Then, the first step is:

$$\frac{\$6{,}000}{(1-0.4)} = \$10{,}000$$

The second step is to plug this figure into our regular formula as follows:

Target income volume = (\$15,000 + \$10,000) / 15 = 1,667 Units

Margin of Safety

The margin of safety is a measure of difference between the actual sales and the break-even sales. It is the amount by which sales revenue may drop before losses begin, and is expressed as a percentage of expected sales:

$$\boxed{\text{Margin of Safety} = \frac{(\text{Expected Sales} - \text{Breakeven Sales})}{\text{Expected Sales}}}$$

FIGURE 1
BREAK-EVEN CHART

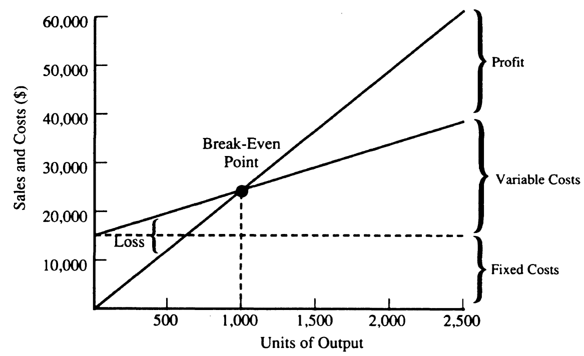
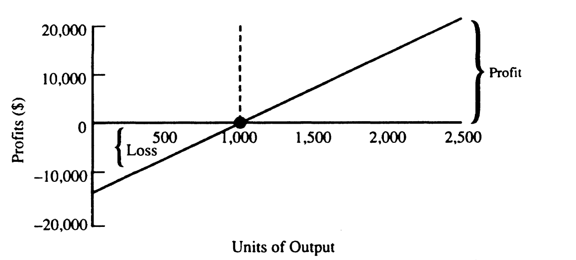


FIGURE 2
PROFIT-VOLUME (P-V) CHART



The margin of safety is used as a measure of operating risk. The larger the ratio, the safer the situation since there is less risk of reaching the break-even point.

EXAMPLE 5

Assume ABC Toy Store projects sales of $35,000 (1,400 units) with a break-even sales level of $25,000 (1,000 units). The projected margin of safety is:

($35,000 - $25,000) / $35,000 or (1,400 – 1,000)/1,400 = 28.57%

SOME APPLICATIONS OF CVP ANALYSIS AND WHAT-IF ANALYSIS

The concepts of contribution margin and the contribution income statement have many applications in profit planning and short-term decision making. Many "what-if" scenarios can be evaluated, especially utilizing a spreadsheet program such as *Excel*. Some applications are illustrated in Examples 6 to 10 using the same data as in Example 1.

EXAMPLE 6

Recall from Example 1 that ABC Toy Store has a CM of 60 percent and fixed costs of $15,000 per period. Assume that the store expects sales to go up by $10,000 for the next period. How much will income increase?

Using the CM concepts, we can quickly compute the impact of a change in sales on profits. The formula for computing the impact is:

Change in net income = Dollar change in sales x CM ratio

Thus:

Increase in net income = $10,000 X 60% = $6,000

Therefore, the income will go up by $6,000, assuming there is no change in fixed costs.
If we are given a change in unit sales instead of dollars, then the formula becomes:

Change in net income = Change in unit sales x Unit CM

EXAMPLE 7

Assume that the store expects sales to go up by 400 units. How much will income increase? From Example 1, the store's unit CM is $15. Again, assuming there is no change in fixed costs, the income will increase by $6,000.

400 units x $15 = $6,000

EXAMPLE 8

What net income is expected on sales of $47,500?

The answer is the difference between the CM and the fixed costs:

CM: $47,500 X 60%	$28,500
Less: Fixed costs	15,000
Net income	$13,500

EXAMPLE 9

ABC Toy Store is considering increasing the advertising budget by $5,000, which would increase sales revenue by $8,000. Should the advertising budget be increased?

The answer is no, since the increase in the CM is less than the increased cost:

Increase in CM: $8,000 X 60%	$4,800
Increase in advertising	5,000
Decrease in net income	$(200)

EXAMPLE 10

Consider the original data. Assume again that ABC Toy Store is currently selling 1,500 units per period. In an effort to increase sales, management is considering cutting its unit price by $5 and increasing the advertising budget by $1,000. If these two steps are taken, management feels that unit sales will go up by 60 percent. Should the two steps be taken?

A $5 reduction in the selling price will cause the unit CM to decrease from $15 to $10. Thus,

Proposed CM: 2,400 units x $10	$24,000
Present CM: 1,500 units x $15	22,500
Increase in CM	$1,500
Increase in advertising outlay	1,000
Increase in net income	$500

The answer, therefore, is yes. Alternatively, the same answer can be obtained by developing comparative income statements in a contribution format:

	(A) Present (1,500 units)	(B) Proposed (2,400 units)	(B - A) Difference
Sales	$37,500 (@$25)	$48,000 (@$20)	$10,500
Less: Variable cost	15,000 (@$10)	24,000 (@$10)	9,000
CM	$22,500	$24,000	$1,500
Less: Fixed costs	15,000	16,000	1,000
Net income	$ 7,500	$ 8,000	$500

SALES MIX ANALYSIS

Break-even and cost-volume-profit analysis requires some additional computations and assumptions when a company produces and sells more than one product. In multi-product firms, sales mix is an important factor in calculating an overall company break-even point.

Different selling prices and different variable costs result in different unit CM and CM ratios. As a result, the break-even points and cost-volume-profit relationships vary with the relative proportions of the products sold, called the *sales mix*.

In break-even and CVP analysis, it is necessary to predetermine the sales mix and then compute a weighted average unit CM. It is also necessary to assume that the sales mix does not change for a specified period. The break-even formula for the company as a whole is:

$$\text{Break-even sales in units (or in dollars)} = \frac{\text{Fixed Costs}}{\text{Weighted Average Unit CM (or CM Ratio)}}$$

EXAMPLE 11

Assume that Knibex, Inc. produces cutlery sets out of high-quality wood and steel. The company makes a deluxe cutlery set and a standard set that have the following unit CM data:

	DELUXE	STANDARD
Selling price	$15	$10
Variable cost per unit	12	5
Unit CM	$3	$5
Sales mix	60%	40%
	(based on sales volume)	
Fixed costs	$76,000	

The weighted average unit CM = (\$3)(0.6) + (\$5)(0.4) = \$3.80. Therefore, the company's break-even point in units is:

\$76,000/\$3.80 = 20,000 units

which is divided as follows:

Deluxe: 20,000 units x 60% =	12,000	units
Standard: 20,000 units x 40% =	8,000	
	20,000	units

Note: An alternative is to build a package containing 3 deluxe models and 2 standard models (3:2 ratio). By defining the product as a package, the multiple-product problem is converted into a single-product one. Then use the following three steps as follows:

Step 1: Computer the package CM as follows:

	DELUXE	*STANDARD*
Selling price	\$15	\$10
Variable cost per unit	12	5
Unit CM	\$3	\$5
Sales mix	3	2
Package CM	\$9	\$10
	\$19 package total	

\$76,000/\$19 per package = 4,000 packages

Step 3: Multiply this number by their respective mix units:

Deluxe:	4,000 packages x 3 units =	12,000	units
Standard:	4,000 packages x 2 units =	8,000	
		20,000	units

EXAMPLE 12

Assume that Dante, Inc. is a producer of recreational equipment. It expects to produce and sell three types of sleeping bags--the Economy, the Regular, and the Backpacker. Information on the bags is given below:

BUDGETED				
	Economy	*Regular*	*Backpacker*	*Total*
Sales	$30,000	$60,000	$10,000	$100,000
Sales mix	30%	60%	10%	100%
Less VC	24,000	40,000	5,000	69,000
	(80%)*	(66 2/3%)	(50%)	(69%)
CM	$6,000	$20,000	$5,000	$31,000**
CM ratio	20%	33 1/3%	50%	31%
Fixed costs				$18,600
Net income				$12,400

*$24,000/$30,000=80%
**$31,000/$100,000=31%

The CM ratio for Dante, Inc. is $31,000/$100,000 = 31 percent.

Therefore the break-even point in dollars is

$18,600/0.31 = $60,000

which will be split in the mix ratio of 3:6:1 to give us the following break-even points for the individual products:

Economy:	$60,000 x 30% =	$18,000
Regular:	$60,000 x 60% =	36,000
Backpacker	$60,000 x 10% =	6,000
		$60,000

One of the most important assumptions underlying CVP analysis in a multi-product firm is that the sales mix will not change during the planning period. But if the sales mix changes, the break-even point will also change.

EXAMPLE 13

Assume that total sales from Example 12 was achieved at $100,000 but that an actual mix came out differently from the budgeted mix (i.e., for Economy, 30% to 55%, for Regular, 60% to 40%, and for Backpacker, 10% to 5%).

	ACTUAL Economy	Regular	Backpacker	Total
Sales	$55,000	$40,000	$5,000	$100,000
Sales mix	55%	40%	5%	100%
Less: VC	44,000*	26,667*	2,500*	69,000
	(80%)	(66 2/3%)	(50%)	(69%)
CM	$11,000	$13,333	$2,500	$26,833
CM ratio	20%	33 1/3%	50%	26.83%**
Fixed Costs				$18,600
Net income				$8,233

* $55,000 x 80% = $44,000; $40,000 x 66.23% = $26,667; $5,000 x 50% = $2,500
**$26,833/$100,000=26.83%

Note: The shift in sales mix toward the less profitable line, Economy, has caused the CM ratio for the company as a whole to drop from 31 percent to 26.83 percent.

The new break-even point will be $18,600/0.2683 = $69,325
The break-even dollar volume has increased from $60,000 to $69,325.

YOU SHOULD REMEMBER

The deterioration (improvement) in the mix caused net income to go down (up). It is important to note that generally, the shift of emphasis from low-margin products to high-margin ones will increase the overall profits of the company.

CVP ANALYSIS WITH STEP-FUNCTION COSTS

The introduction of step-function costs is somewhat more difficult than it might first appear. Ideally, we would like to be able to assume that, for any given relevant range, we could simply add together the step-function costs and the fixed costs to give us the total applicable fixed costs. We then could utilize the formula as described above. Unfortunately, the process is not quite that simple, as the following example illustrates.

EXAMPLE 14

Amco Magazine Company publishes a monthly magazine. The company has fixed costs of $100,000 a month, variable costs per magazine of $.80, and charges $1.80 per magazine. In addition, the company also has supervisory costs. These costs behave as follows:

Volume	*Costs*
0 - 50,000	$ 10,000
50,001 - 100,000	20,000
100,001 - 150,000	30,000

Amco's monthly break-even volume (number of magazines) can be calculated, step by step, as follows:

First, if we attempt to solve the break-even formula at the first level of fixed costs, we have the following equation:

$$\begin{aligned} x &= FC/(p\text{-}v) \\ &= (\$100{,}000 + 10{,}000)/(\$1.80 - \$.80) \\ &= \$110{,}000/.\$1 \\ &= 110{,}000 \text{ units} \end{aligned}$$

The problem with this solution is that, while the break-even volume is 110,000 magazines, the relevant range for the step-function costs was only 0 - 50,000 magazines. Thus, a break-even of greater than 50,000 magazines is invalid and we must move to the next step on the step function, which gives us the following equation:

$$\begin{aligned} x &= FC/(p\text{-}v) \\ &= (\$100{,}000 + 20{,}000)/(\$1.80 - \$.80) \\ &= \$120{,}000/.\$1 \\ &= 120{,}000 \text{ units} \end{aligned}$$

This solution is also invalid. Only when we get to the third level do we encounter a valid solution, as follows:

$$\begin{aligned} x &= FC/(p\text{-}v) \\ &= (\$100{,}000 + 30{,}000)/(\$1.80 - \$.80) \\ &= \$130{,}000/.\$1 \\ &= 130{,}000 \text{ units} \end{aligned}$$

The conclusion we must draw is that the incorporation of step-function costs in the CVP formula requires a trial-and-error process to reach the break-even volume.

From a profit-seeking perspective, a 150,000 unit level is most profitable.

	50,000	100,000	150,000
CM(@1)	$ 50,000	$100,000	$150,000
FC	100,000	120,000	130,000
NI	($50,000)	($20,000)	$ 20,000

ASSUMPTIONS UNDERLYING BREAK-EVEN AND CVP ANALYSIS

The basic break-even and CVP models are subject to a number of limiting assumptions. They are:

(a) The selling price per unit is constant throughout the entire *relevant range* of activity.
(b) All costs are classified as fixed or variable.
(c) The variable cost per unit is constant.
(d) There is only one product or a constant sales mix.
(e) Inventories do not change significantly from period to period.
(f) Volume is the only factor affecting variable costs.

CHAPTER SUMMARY

Cost-volume-profit analysis is useful as a frame of reference, as a vehicle for expressing overall managerial performance, and as a planning device via break-even techniques and "what-if" scenarios. The following points highlight the analytical usefulness of CVP analysis as a tool for profit planning:

1. A change in either the selling price or the variable cost per unit alters CM or the CM ratio and thus the break-even point.

2. As sales exceeds the break-even point, a higher unit CM or CM ratio will result in greater profits than a small unit CM or CM ratio.

3. The lower the break-even sales, the less risky the business and the safer the investment, other things being equal.

4. A large margin of safety means lower operating risk since a large decrease in sales can occur before losses are experienced

5. Using the contribution income statement model and a spreadsheet program such as Excel, a variety of "what-if" planning and decision scenarios can be evaluated.

6. In a multi-product firm, sales mix is often more important than overall market share. The emphasis on high-margin products tends to maximize overall profits of the firm.

CHAPTER 6
ANALYSIS OF COST BEHAVIOR

Not all costs behave in the same way. There are certain costs that vary in proportion to changes in volume or activity, such as labor hours and machine hours. There are other costs that do not change even though volume changes. An understanding of cost behavior is helpful:

1. For break-even and cost-volume-profit analysis.
2. To appraise divisional performance.
3. For flexible budgeting.
4. To make short-term choice decisions
5. To make transfer decisions

After studying the material in this chapter, you will be able to

- Define and cite examples of variable costs, fixed costs, and mixed costs.
- Explain four methods of estimating cost functions: engineering analysis, account analysis, High-Low method, and Least-Squares Regression Method.
- List the advantages and disadvantages of the high-low method for developing a cost-volume formula.
- Distinguish between committed and discretionary fixed costs.
- Develop a formula using the high-low method.
- List the advantages and disadvantages of the least-squares method.
- Develop a cost-volume formula using the least-squares method.
- Utilize a spreadsheet program such as *MS Excel* to develop the least-squares equation.
- Describe various regression statistics such as the coefficient of determination and t-value.
- State the need for multiple regression analysis.

A FURTHER LOOK AT COSTS BY BEHAVIOR

As was discussed in Chapter 2 (Cost Classifications, Terminology, and Profit Concepts), depending on how a cost will react or respond to changes in the level of activity, costs may be viewed as variable, fixed, or mixed (semi-variable). This classification is made within a specified range of activity, called the relevant range. The relevant range is the volume zone within which the behavior of variable costs, fixed costs, and selling prices can be predicted with reasonable accuracy.

VARIABLE COSTS. Variable costs, also known as *engineered costs*, vary in total with changes in volume or level of activity. Examples of variable costs include the costs of direct materials, direct labor, and sales commissions. The following factory overhead items fall in the variable cost category:

Variable Factory Overhead

Supplies	Receiving Costs
Fuel and Power	Overtime Premium
Spoilage and Defective Work	

FIXED COSTS. Fixed costs do not change in total regardless of the volume or level of activity. Examples include advertising expense, salaries, and depreciation. The following factory overhead items fall in the fixed cost category:

Fixed Factory Overhead

Property Taxes	Rent on Factory Building
Depreciation	Indirect labor
Insurance	Patent Amortization

MIXED (SEMI-VARIABLE) COSTS. As previously discussed, mixed costs contain both a fixed element and a variable one. Salespersons' compensation including salary and commission is an example. The following factory overhead items may be considered mixed costs:

Mixed Factory Overhead

Supervision	Maintenance and Repairs
Inspection	Workmen's Compensation Insurance
Service Department costs	Employer's Payroll Taxes
Utilities	Rental of Delivery Truck
Fringe Benefits	Quality Costs
Cleanup costs	

Note that factory overhead, taken as a whole, would be a perfect example of mixed costs. Figure 1 displays how each of these three types of costs varies with changes in volume.

TYPES OF FIXED COSTS – COMMITTED OR DISCRETIONARY

Strictly speaking, there is no such thing as a fixed cost. In the long run, all costs are variable. In the short run, however, some fixed costs, called *discretionary* (or *managed* or *programmed*) fixed costs, will change. It is important to note that these costs change because of managerial decisions, not because of changes in volume. Examples of discretionary types of fixed costs are advertising, training, and research and development.

Another type of fixed costs, called *committed* (or *capacity*) fixed costs, are those costs that do not change and are the results of commitments previously made. Fixed costs such as rent, depreciation, insurance, and executive salaries are committed types of fixed costs since management has committed itself for a long period of time regarding the company's production facilities and manpower requirements.

COST ACCOUNTING IN ACTION—Analyzing Cost Behavior in Hospitals

Healthcare costs, rising faster than inflation, now account for more than 10% of total gross domestic product (GDP). Concerns about these rising costs have prompted hospital administrators to improve cost accounting practices so they can understand how to cut costs without reducing the quality of healthcare services provided. These cost systems typically break down costs into fixed and variable components by service. “For example, if it costs $100 to do 10 laboratory tests, do 11 tests cost $110? It’s possible the extra test may cost only $3 because all of the fixed cost was already covered by the first 10 tests.

Knowing the cost function is $70 fixed costs plus $3 variable cost per laboratory test is more informative than knowing the cost is $100 for 10 tests. Armed with the breakdown of costs into fixed and variable components, the laboratory administrators know they could afford to charge less than $10 per test if the volume increases, On the other hand, they know that if volume decreases below 10 tests, charging $10 per test will not be sufficient to cover costs.

Source: Judith Nemes, “Tight Margins Lead Hospital to Cost Accounting Systems,” *Modern Healthcare,* December 17, 1990, pp. 23-30.

ANALYSIS OF MIXED (SEMI-VARIABLE) COSTS

For planning, control, and decision making purposes, mixed costs need to be separated into their variable and fixed components. Since the mixed costs contain both fixed and variable elements, the analysis takes the following mathematical form, which is called a cost-volume formula (*flexible budget formula* or *cost function*):

$$y = a + bx$$

where y = the mixed cost to be broken up.
x = any given measure of activity (cost driver) such as direct labor hours, machine hours, or production volume.
a = the fixed cost component.
b = the variable rate per unit of x.

Relevant Range

Management quite often uses the notion of relevant range in estimating cost behavior. The relevant range is the range of activity over which the company expects a set of cost behaviors to be consistent (or linear). For example, if the relevant range of activity is between 10,000 and 20,000 units of cars, the auto maker assumes that certain costs are fixed and while others are variable within that range.

Separating the mixed cost into its fixed and variable components is the same thing as estimating the parameter values a and b in the cost-volume formula. There are several methods available to be used for this purpose including the high-low method and the least- squares method (regression analysis). They are discussed below.

ENGINEERING ANALYSIS

Engineering analysis measures cost behavior according to what costs *should be*, not by what costs *have been*. It entails a systematic review of materials, labor, support services, and facilities needed for product and services. Engineers use time and motion studies and similar engineering methods to estimate what costs should be from engineers' specifications of the inputs required to manufacture a unit of output or to perform a particular service. This can be used for existing products or for new products similar to what has been produced before. Disadvantages of this method are that it is prohibitively costly and often not timely. Further its is difficult to estimate indirect costs. The engineering method is most useful when costs involved are variable costs, where there is a clear input/output relation.

ACCOUNT ANALYSIS

Account analysis selects a volume-related cost driver, and classifies each account from the accounting records as a variable or fixed cost. The cost accountant then looks at each cost account balance and estimates either the variable cost per unit of cost driver activity or the periodic fixed cost. Account analysis requires a detailed examination of the data, presumably by cost accountants and managers who are familiar with the activities of the company, and the way the company's activities affect costs. Because account analysis is judgmental, different analysts are likely to provide different estimates of cost behavior.

EXAMPLE 1

The cafeteria department of Los Al Health Center reported the following costs for October 20X1:

Monthly Cost	*October 20X1 Amount*
Food and beverages	$9,350
Hourly wages and benefits	18,900
Supervisor's salary	4,000
Equipment depreciation and rental	6,105
Supplies	2,760
Total cafeteria costs	$41,115

The cafeteria served 11,520 meals during the month. Using an account analysis to classify costs, we can determine the cost function. Note that in this example, the supervisor's salary ($4,000 per month) and the equipment depreciation and rental ($6,105 per month) are fixed while the remainder ($31,010) varies with the cost drive, i.e., the number of meals served. Dividing the variable costs by the number of meals served yields $2.692 and the department's cost-volume formula is

$10,105 + $2.692 per meal.

THE HIGH – LOW METHOD

The high-low method, as the name indicates, uses two extreme data points to determine the values of a (the fixed cost portion) and b (the variable rate) in the equation $y = a + bx$. The extreme data points are the highest representative x-y pair and the lowest representative x-y pair. The activity level x, rather than the mixed cost item y, governs their selection.

The high-low method is explained, step by step, as follows:

Step 1 Select the highest pair and the lowest pair

Step 2 Compute the variable rate, b, using the formula:

$$\text{Variable rate} = \frac{\text{Difference in cost y}}{\text{Difference in activity x}}$$

Step 3 Compute the fixed cost portion as:

Fixed cost portion = Total mixed cost - Variable cost (or $a = y - bx$)

EXAMPLE 2

Flexible Manufacturing Company decided to relate total factory overhead costs to direct labor hours (DLH) to develop a cost-volume formula in the form of y = a + bx. Twelve monthly observations are collected. They are given in Table 1 and plotted as shown in Figure 2.

TABLE 1

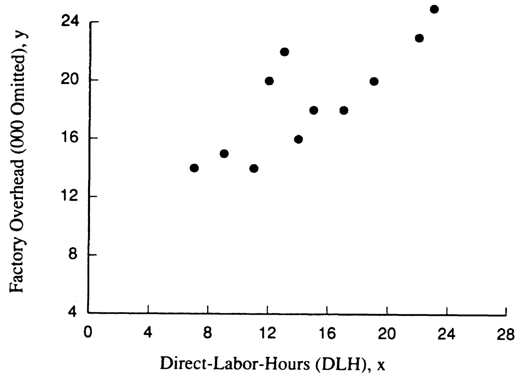
Month	*Direct Labor Hours (x) (000 omitted)*	*Factory Overhead (y) (000 omitted)*
January	9 hours	$15
February	19	20
March	11	14
April	14	16
May	23	25
June	12	20
July	12	20
August	22	23
September	7	14
October	13	22
November	15	18
December	17	18
Total	174 hours	$225

The high-low points selected from the monthly observations are

	X	*Y*
High	23 hours	$25 (May pair)
Low	7	14 (September pair)
Difference	16 hours	$11

FIGURE 2

SCATTER DIAGRAM



Thus

$$\text{Variable rate b} = \frac{\text{Difference in Y}}{\text{Difference in X}} = \frac{\$11}{16\text{ hours}} = \$0.6875 \text{ per DLH}$$

The fixed cost portion is computed as:

	High	*Low*
Factory overhead (y)	$25	$14
Variable expense($0.6875 per DLH)	(15.8125)*	(4.8125)*
	9.1875	9.1875

*$0.6875 x 23 hours = $15.8125; $0.6875 x 7 hours = $4.8125

Therefore, the cost-volume formula for factory overhead is

$9.1875 fixed plus $0.6875 per DLH.

The high-low method is simple and easy to use. It has the disadvantage, however, of using two extreme data points, which may not be representative of normal conditions. The method may yield unreliable estimates of a and b in our formula. In such a case, it would be wise to drop them and choose two other points that are more representative of normal situations. Be sure to check the scatter diagram for this possibility.

Note: Regardless of choice of the method, whether the high-low method -- or the least-squares method, for that matter -- the analyst must plot the observed data on a scatter diagram (also called a scattergraph or scatterplot). The reason is that the relationship between y and x shows a *linear* pattern in order to justify the use of the linear form y = a + bx.

Especially for the high-low method, with a scatter diagram (1) it is easier to locate the highest and lowest pairs on the diagram than on the table and (2) it allows the analyst to ensure that the two points chosen are not extreme outliners (i.e., they must be representative of the normal behavior).

REGRESSION ANALYSIS

One popular method for estimating the cost-volume formula is regression analysis. Regression analysis is a statistical procedure for estimating mathematically the average relationship between the dependent variable and the independent variable(s). *Simple regression* involves one independent variable, e.g., DLH or machine hours alone, whereas *multiple regression* involves two or more activity variables.

In this chapter, we will discuss *simple (linear) regression* to illustrate the *least-squares method*, which means that we will assume the Y = a + bX relationship.

Unlike the high-low method, in an effort to estimate the variable rate and the fixed cost portion, the regression method includes all the observed data and attempts to find a line of best fit. To find this line, a technique called the least-squares method is used.

To explain the least-squares method, we define the error as the difference between the observed value and the estimated one of some mixed cost and denote it with u.

Symbolically, u = y - y

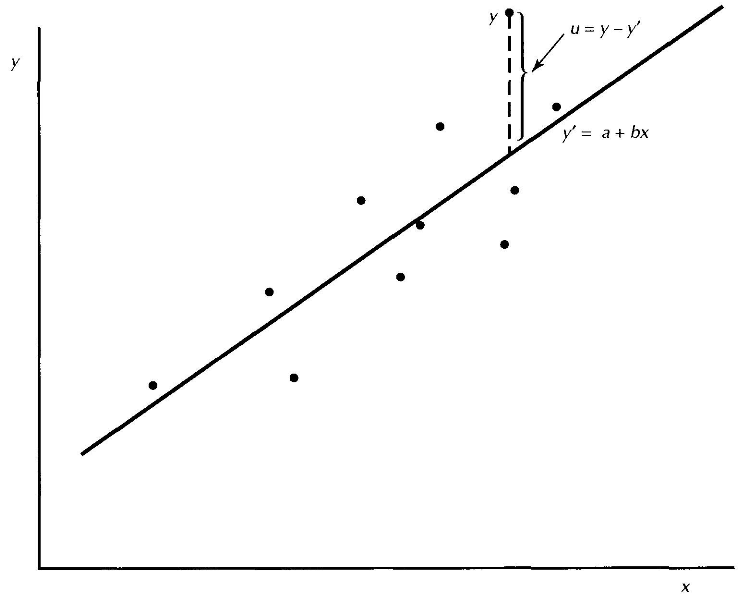
where y = observed value of a mixed (semivariable) expense
y' = estimated value based on y' = a + bx

The least-squares criterion requires that the line of best fit be such that the sum of the squares of the errors (or the vertical distance in Figure 3 from the observed data points to the line) is a minimum, i.e.,

$$\text{Minimum: } \sum u^2 = \sum(y - y')^2 = \sum(y\text{-}a\text{-}bx)^2$$

:

FIGURE 3
Y AND Y'



Using differential calculus we obtain the following equations, called normal equations

$$\sum y = na + b\sum x$$

$$\sum xy = a\sum x + b\sum x^2$$

solving the equations for b and a yields

$$b = \frac{n\sum XY - (\sum X)(\sum Y)}{n\sum X^2 - (\sum X)^2}$$

$$a = \overline{Y} - b\overline{X}$$

$$\text{where } \overline{Y} = \frac{\sum Y}{n} \text{ and } \overline{X} = \frac{\sum X}{n}$$

EXAMPLE 3

To illustrate the computations of b and a, we will refer to the data in Table 2. All the sums required are computed and shown below.

TABLE 1

DLH (x)	*Factory Overhead (y)*	*xy*	*x^2*	*y^2*
9 hours	$15	135	81	225
19	20	380	361	400
11	14	154	121	196
14	16	224	196	256
23	25	575	529	625
12	20	240	144	400
12	20	240	144	400
22	23	506	484	529
7	14	98	49	196
13	22	286	169	484
15	18	270	225	324
17	18	306	289	324
174 hours	$225	3,414	2,792	4,359

From the table above:

$\Sigma X = 174$; $\Sigma Y = 225$; $\Sigma XY = 3{,}414$; $\Sigma X^2 = 2{,}792$.

$\overline{X} = \Sigma X/n = 174/12 = 14.5$; $\overline{Y} = \Sigma Y/n = 225/12 = 18.75$.

Substituting these values into the formula for b first:

$$b = \frac{n\sum XY - (\sum X)(\sum Y)}{n\sum X^2 - (\sum X)^2} = \frac{(12)(3{,}414) - (174)(225)}{(12)(2{,}792) - (174)^2} = \frac{1{,}818}{3{,}228} = 0.5632$$

$$a = \overline{Y} - b\overline{X} = 18.75 - (0.5632)(14.5) = 18.75 - 8.1664 = 10.5836$$

The cost-volume formula then is

$$y' = \$10.5836 + \$0.5632\ x$$
or $10.5836 fixed, plus $0.5632 per DLH

Note: $\sum y^2$ is not used here but rather is computed for future use.

EXAMPLE 4

Assume that the direct labor hours of 10 are to be expended for next year. The projected factory overhead for the next year would be computed as follows:

$$\begin{aligned} y' &= 10.5836 + 0.5632\ x \\ &= 10.5836 + 0.5632\ (10) \\ &= \$16.2156 \end{aligned}$$

REGRESSION STATISTICS

Unlike the high-low method, regression analysis is a statistical method. It uses a variety of statistics to tell about the accuracy and reliability of the regression results. They include:

1. Correlation coefficient (r) and coefficient of determination (r^2)

2. Standard error of the estimate (S_e) and prediction confidence interval

3. Standard error of the regression coefficient (S_b) and t-statistic

Only the first ones are explained in this course.

Correlation coefficient (r) and coefficient of determination (r^2)

The correlation coefficient r measures the degree of correlation between y and x. The range of values it takes on is between -1 and +1. More widely used, however, is the coefficient of determination, designated r^2 (read as r-squared).

Simply put, r^2 tells us how good the estimated regression equation is. In other words, it is a measure of "goodness of fit" in the regression. Therefore, the higher the r^2, the more confidence we have in our cost volume formula.

More specifically, the coefficient of determination represents the proportion of the total variation in y that is explained by the regression equation. It has the range of values between 0 and 1.

YOU SHOULD REMEMBER

A low r^2 is an indication that the model is inadequate for explaining the y variable. The general causes for this problem are:

1. Use of a wrong functional form.
2. Poor choice of an x variable as the predictor.
3. The omission of some important variable or variables from the model.

Note: r^2 is a measure of goodness of fit. Even though the line, obtained by the use of the least-squared error rule, is supposed to be the line of best-fit, it may still be inaccurate. The least-square line may have been the best among the *linear* lines. The observed data, however, may exhibit a *curvilinear* pattern, which cannot be visualized especially in multiple regressions. In other words, since it is impossible to draw the scatter diagram in a multi-variable situation, we must rely on a statistic such as r^2 to determine the degree of the goodness of fit. Note that low values of r^2 indicate that the cost driver does not fully explain cost behavior.

EXAMPLE 5

The statement "Factory overhead is a function of direct labor hours with r^2 = 70 percent," can be interpreted as "70 percent of the total variation of factory overhead is explained by the regression equation or the change in direct labor hours and the remaining 30 percent is accounted for by something other than direct labor hours, such as machine hours."

The coefficient of determination is computed as

$$R^2 = 1 - \frac{\sum (Y - Y')^2}{\sum (Y - \bar{Y})^2}$$

In a simple regression situation, however, there is a short-cut method available:

$$R^2 = \frac{[n\sum XY - (\sum X)(\sum Y)]^2}{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}$$

Comparing this formula with the one for b, we see that the only additional information we need to compute R^2 is ΣY^2.

Note: For computational ease, we often calculate r first, using:

$$R = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2]}\sqrt{[n\sum Y^2 - (\sum Y)^2]}}$$

and then square R i.e. $R^2 = (R)^2$

EXAMPLE 6

To illustrate the computations of various regression statistics, we will refer to the data in Table 1. Using the shortcut method for R^2,

$$R^2 = \frac{(1{,}818)^2}{[3{,}228][(12)(4{,}359) - (225)^2]} = \frac{3{,}305{,}124}{[3{,}228][52{,}308 - 50{,}625]} = \frac{3{,}305{,}124}{(3{,}228)(1{,}683)}$$

$$= \frac{3{,}305{,}124}{5{,}432{,}724} = 0.6084 = 60.84\%$$

This means that about 60.84 percent of the total variation in factory overhead is explained by direct labor hours and the remaining 39.16 percent is still unexplained. A relatively low r^2 indicates that there is a lot of room for improvement in our estimated cost volume formula (y' = \$10.5836 + \$0.5632x). Machine hours or a combination of direct labor hours and machine hours might improve r^2.

USE OF COMPUTER SOFTWARE FOR REGESSION

We can use a electronic spreadsheet program such as *Excel* in order to develop a model and estimate most of the statistics we discussed thus far.

USING REGRESSION ON *EXCEL*

To utilize Excel for regression analysis, the following procedure needs to be followed:

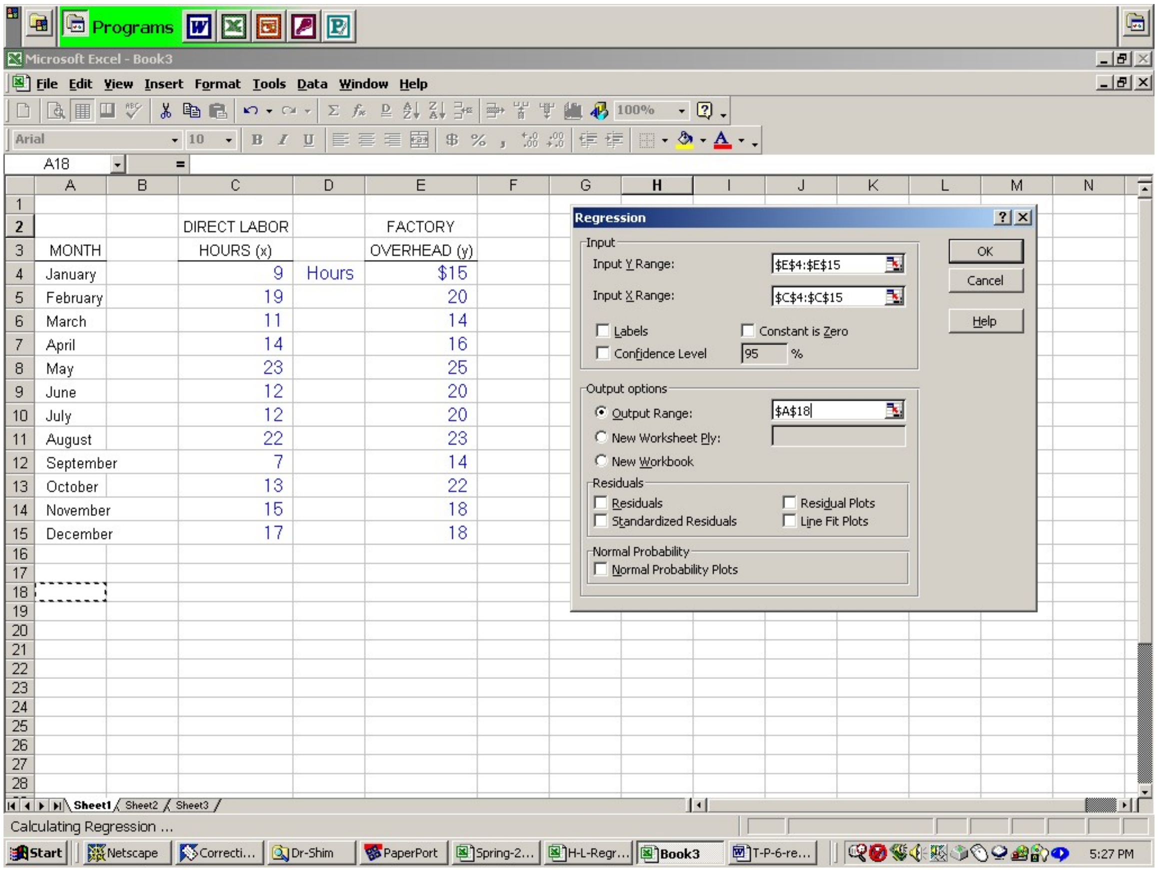
1. Click the *Tools* menu.
2. Click *Add-Ins.*
3. Click *Analysis ToolPak*. (If Analysis ToolPak is not listed among your available add-ins, exit *Excel*, double-click the MS Excel Setup icon, click Add/Remove, double-click Add-Ins, and select Analysis ToolPak. Then restart Excel and repeat the above instruction.)

After ensuring that the Analysis ToolPak is available, you can access the regression tool by completing the following steps:

1. Click the *Tools* menu.
2. Click *Data Analysis*.
3. Click *Regression*

Note: To obtain a scattergraph, use Excel's Chart Wizard.

The following captures the Regression input dialog screen.



EXCEL REGRESSION OUTPUT

Figure 4 shows the Excel regression output.

FIGURE 4

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7800
R Square	0.6084
Adjusted R Square	0.5692
Standard Error	2.3436
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	85.3243	85.3243	15.5345	0.0028
Residual	10	54.9257	5.4926		
Total	11	140.25			

	Coefficients	*Standard Error*	*t Stat*	*P-value**	*Lower 95%*	*Upper 95%*
Intercept	10.583643	2.1796	4.8558	0.0007	5.7272	15.4401
DLH	0.563197	0.1429	3.9414	0.0028	0.2448	0.8816

*The P-value for X Variable = .0028 indicates that we have a 0.28% chance that the true value of the variable coefficient is equal to 0, implying a high level of accuracy about the estimated value of 0.563197.

The result shows:

$$Y' = 10.58364 + 0.563197\ X \quad \text{(in the form of } Y' = a + bX)$$

with: R-squared ($R^2 = 0.608373 = 60.84\%$)

All of the above are the same as the ones manually obtained.

The following is the regression output from popular statistical software, *Minitab.*

MINITAB REGRESSION OUTPUT

Regression Analysis

```
The regression equation is
FO = 10.6 + 0.563 DLH

Predictor       Coef       Stdev    t-ratio       p
Constant      10.584       2.180       4.86   0.000
DLH           0.5632      0.1429       3.94   0.003

s = 2.344       R-sq = 60.8%     R-sq(adj) = 56.9%

Analysis of Variance

SOURCE        DF          SS          MS         F        p
Regression     1      85.324      85.324     15.53    0.003
Error         10      54.926       5.493
Total         11     140.250
```

CHAPTER SUMMARY

Cost/managerial accountants analyze cost behavior for cost-volume-profit analysis, for appraisal of managerial performance, for flexible budgeting, and to make short-term choice decisions. We have looked at three types of cost behavior---variable, fixed, and mixed. We illustrated two popular methods of separating mixed costs in their variable and fixed components: the high-low method and regression analysis. Heavy emphasis was placed on the use of simple and multiple regressions.

CHAPTER 7
BUDGETING FOR PROFIT PLANNING

A comprehensive (master) budget is a formal statement of management's expectation regarding sales, expenses, volume, and other financial transactions of an organization for the coming period. Simply put, a budget is a set of pro forma (projected or planned) financial statements. It consists basically of a pro forma income statement, pro forma balance sheet and cash budget.

A budget is a tool for both planning and control. At the beginning of the period, the budget is a plan or standard; at the end of the period it serves as a control device to help management measure its performance against the plan so that future performance may be improved.

It is important to realize that with the aid of computer technology, budgeting can be used as an effective device for evaluation of "what-if" scenarios. This way management should be able to move toward finding the best course of action among various alternatives through simulation.

If management does not like what they see on the budgeted financial statements in terms of various financial ratios such as liquidity, activity (turnover), leverage, profit margin, and market value ratios, they can always alter their contemplated decision and planning set.

After studying the material in this chapter, you will be able to

- Define budgeting.
- Diagram and explain the master budget interrelationships.
- Prepare sales, production, cost, and cash budgets.
- Develop a pro forma balance sheet and pro forma income statement.
- State how budgets aid in planning and control and how a computer-based financial modeling approach may be used in the planning process.
- Distinguish between traditional budgeting and zero base budgeting (ZBB).

TYPES OF BUDGETS

The budget is classified broadly into two categories:

1. Operating budget, reflecting the results of operating decisions.
2. Financial budget, reflecting the financial decisions of the firm.

The operating budget consists of:

- Sales budget
- Production budget
- Direct materials budget
- Direct labor budget
- Factory overhead budget
- Selling and administrative expense budget
- Pro forma income statement

The financial budget consists of:

- Cash budget
- Pro forma balance sheet

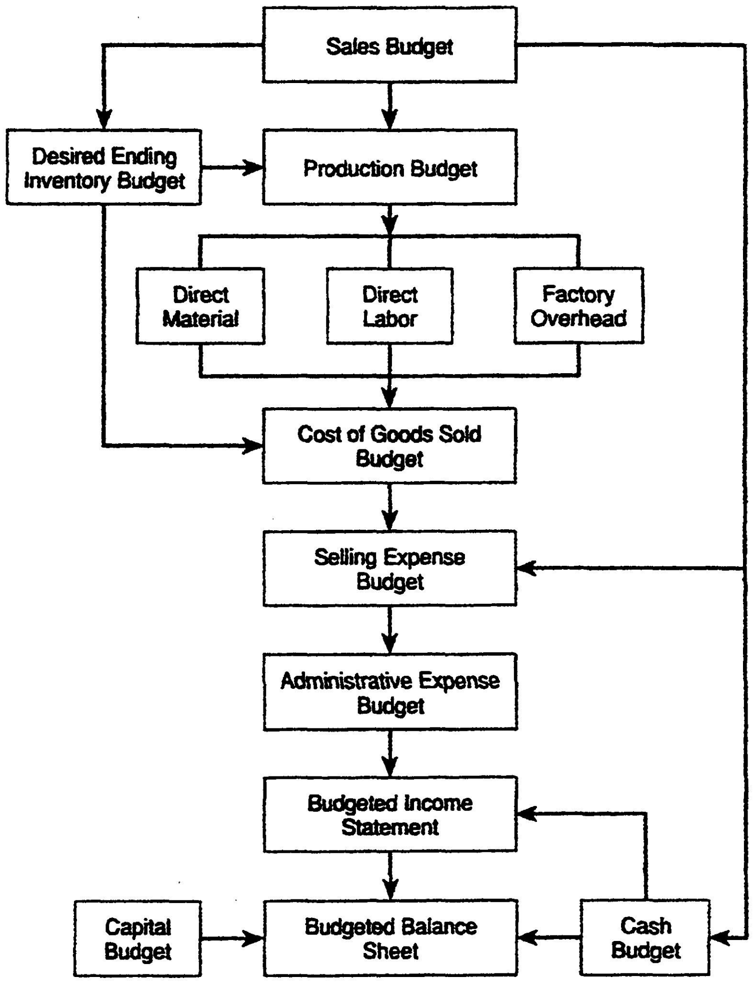
The major steps in preparing the budget are:

1. Prepare a sales forecast.
2. Determine expected production volume.
3. Estimate manufacturing costs and operating expenses.
4. Determine cash flow and other financial effects.
5. Formulate projected financial statements.

Figure 1 shows a simplified diagram of the various parts of the comprehensive (master) budget, the master plan of the company.

FIGURE 1

COMPREHENSIVE (MASTER) BUDGET



ILLUSTRATION

To illustrate how all these budgets are put together, we will focus on a *manufacturing* company called the Putnam Company, which produces and markets a single product. We will make the following assumptions:

- The company uses a single material and one type of labor in the manufacture of the product.
- It prepares a master budget on a *quarterly* basis.

- Work in process inventories at the beginning and end of the year are negligible and are ignored.
- The company uses a single cost driver—direct labor hours (DLH)--as the allocation base for assigning all factory overhead costs to the product.

THE SALES BUDGET

The sales budget is the starting point in preparing the master budget, since estimated sales volume influences nearly all other items appearing throughout the master budget. The sales budget should show total sales in quantity and value. The expected total sales can be break-even or target income sales or projected sales. It may be analyzed further by product, by territory, by customer and, of course, by seasonal pattern of expected sales.

Generally, the sales budget includes a computation of expected cash collections from credit sales, which will be used later for cash budgeting.

SCHEDULE 1

THE PUTNAM COMPANY
Sales Budget
For the Year Ended December 31, 20B

	QUARTER				Year as
	1	2	3	4	a Whole
Expected sales in units*	1,000	1,800	2,000	1,200	6,000
Unit sales price*	x $150	x$150	x$150	x$150	x$150
Total sales	$150,000	$270,000	$300,000	$180,000	$900,000

*Given.

SCHEDULE OF EXPECTED CASH COLLECTIONS

Accounts receivable, 12/31/20A	100,000+				$100,000
1st quarter sales ($150,000)	60,000++	$ 90,000+++			150,000
2d quarter sales ($270,000)		108,200	$162,000		270,000
3d quarter sales ($300,000)			120,000	$180,000	300,000
4th quarter sales ($180,000)				72,000	72,000
Total cash collections	$160,000	$198,000	$282,000	$252,000	$892,000

\+ All of the $100,000 accounts receivable balance is assumed to be collectible in the first quarter.
++ 40 percent of a quarter's sales are collected in the quarter of sale.
+++ 60 percent of a quarter's sales are collected in the quarter following.

MONTHLY CASH COLLECTIONS FROM CUSTOMERS

Frequently, there are time lags between monthly sales made *on account* and their related monthly cash collections. For example, in any month, credit sales are collected as follows: 15% in month of sale, 60% in the following month, 24% in the month after, and the remaining 1 percent are uncollectible.

	April-Actual	*May-Actual*	*June-Budgeted*	*July-Budgeted*
Credit sales	$320	200	300	280

The budgeted cash receipts for June and July are computed as follows:

For June:

From April sales	$320 x .24	$ 76.80
From May sales	200 x .6	120.00
From June sales	300 x .15	45.00
Total budgeted collections in June		$241.80

For July:

From May sales	$200 x .24	$ 48
From June sales	300 x .6	180
From July sales	280 x .15	42
Total budgeted collections in July		$270

THE PRODUCTION BUDGET

After sales are budgeted, the production budget can be determined. The production budget is a statement of the output by product and is generally expressed in units. It should take into account the sales budget, plant capacity, whether stocks are to be increased or decreased and outside purchases. The number of units expected to be manufactured to meet budgeted sales and inventory requirements is set forth in the production budget.

Expected Production Volume = Planned sales + Desired ending Inventory □ Beginning inventory

The production budget is illustrated as follows:

SCHEDULE 2

THE PUTNAM COMPANY
Production Budget
For the Year Ended December 31, 20B

	QUARTER				
	1	2	3	4	Year as a Whole
Planned sales (Schedule 1)	1,000	1,800	2,000	1,200	6,000
Desired ending inventory*	180	200	120	300 **	300
Total Needs	1,180	2,000	2,120	1,500	6,300
Less: Beginning inventory	200 **	180***	200	120	200
Units to be produced	980	1,820	1,920	1,380	6,100

* 10 percent of the next quarter's sales. (For example, 180 = 10% x 1,800).
** Given.
*** The same as the previous quarter's ending inventory.

INVENTORY PURCHASES – MERCHANDISING FIRM

Putnam Company is a manufacturing firm, so it prepares a production budget, as shown in Schedule 2. If it were a *merchandising* (retailing or wholesaling) firm, then instead of a production budget, it would develop a *merchandise purchase budget* showing the amount of goods to be purchased from its suppliers during the period. The merchandise purchases budget is in the same basic format as the production budget, except that it shows *goods to be purchased* rather than goods to be produced, as shown below:

Budgeted cost of goods sold (in units or dollars)	$500,000
Add: Desired ending merchandise inventory	120,000
Total needs	$620,000
Less: Beginning merchandise inventory	(90,000)
Required purchases (in units or in dollars)	$530,000

THE DIRECT MATERIAL BUDGET

When the level of production has been computed, a direct material budget should be constructed to show how much material will be required for production and how much material must be purchased to meet this production requirement.

The purchase will depend on both expected usage of materials and inventory levels. The formula for computation of the purchase is:

Purchase in units	= Usage + Desired ending material inventory units - Beginning inventory units

The direct material budget is usually accompanied by a computation of expected cash payments for materials.

SCHEDULE 3

THE PUTNAM COMPANY
Direct Material Budget
For the Year Ended December 31, 20B

	QUARTER				
	1	2	3	4	Year as a Whole
Units to be produced (Sch.2)	980	1,820	1,920	1,380	6,100
Material needs per unit (lbs)*	x 2	x 2	x 2	x 2	x 2
Production needs (usage)	1,960	3,640	3,840	2,760	12,200
Desired ending inventory of materials**	910	960	690	520 ***	520
Total needs	2,870	4,600	4,530	3,280	12,720
Less: Beginning inventory of materials	490 **	910****	960	690	490
Materials to be purchased	2,380	3,690	3,570	2,590	12,230
Unit price*	x $5	x $5	x $5	x $5	x $5
Purchase cost	$11,900	$18,450	$17,850	$12,950	$61,150

* Given

** 25 percent of the next quarter's units needed for production. For example, the 2nd quarter production needs are 3,640 lbs. Therefore, the desired ending inventory for the 1st quarter would be 25% x 3,640 lbs. = 910 lbs. Also note: 490 lbs = 25% x 1,960 = 490 lbs.

*** Assume that the budgeted production needs in lbs. for the 1st quarter of 20C = 2,080 lbs. So, 25% x 2,080 lbs. = 520 lbs.

**** The same as the prior quarter's ending inventory.

SCHEDULE OF EXPECTED CASH DISBURSEMENTS

Accounts payable,12/31/20A	$6,275+				$ 6,275
1st quarter purchases($11,900)	5,950++	5,950++			11,900
2d quarter purchases($18,450)		9,225	9,225		18,450
3d quarter purchases($17,850)			8,925	8,925	17,850
4th quarter sales ($12,950)				6,475	6,475
Total disbursements	$12,225	$15,175	$18,150	$15,400	$60,950

\+ All of the $6,275 accounts payable balance (from the balance sheet, 20A) is assumed to be paid in the first quarter.

++ 50 percent of a quarter's purchases are paid for in the quarter of purchase; the remaining 50% are paid for in the following quarter.

THE DIRECT LABOR BUDGET

The production requirements as set forth in the production budget also provide the starting point for the preparation of the direct labor budget. To compute direct labor requirements, expected production volume for each period is multiplied by the number of direct labor hours required to produce a single unit. The direct labor hours to meet production requirements is then multiplied by the (standard) direct labor cost per hour to obtain budgeted total direct labor costs.

SCHEDULE 4

THE PUTNAM COMPANY
Direct Labor Budget
For the Year Ended December 31, 20B

	QUARTER				
	1	2	3	4	Year as a Whole
Units to be produced (Sch.2)	980	1,820	1,920	1,380	6,100
Direct labor hours per unit*	x 5	x 5	x 5	x 5	x 5
Total hours	4,900	9,100	9,600	6,900	30,500
Direct labor cost per hour*	x $10	x $10	x $10	x $10	x $10
Total direct labor cost	$49,000	$91,000	$96,000	$69,000	$305,000

*Both are given.

THE FACTORY OVERHEAD BUDGET

The factory overhead budget should provide a schedule of all manufacturing costs other than direct materials and direct labor. We must remember that depreciation does not entail a cash outlay and therefore must be deducted from the total factory overhead in computing cash disbursement for factory overhead.

SCHEDULE 5

To illustrate the factory overhead budget, we will assume that

- Total factory overhead budgeted = $18,300 fixed (per quarter), plus $2 per hour of direct labor. This is one example of a cost-volume (or flexible budget) formula ($y = a + bx$), developed via the *least-squares method* with a high R^2 .
- Depreciation expenses are $4,000 each quarter.
- Overhead costs involving cash outlays are paid for in the quarter incurred.

SCHEDULE 3

THE PUTNAM COMPANY
Factory Overhead Budget
For the Year Ended December 31, 20B

	QUARTER				
	1	2	3	4	Year as a Whole
Budgeted direct labor	4,900	9,100	9,600	6,900	30,500
Variable overhead rate	x $2	x $2	x $2	x $2	x $2
Variable overhead budgeted	9,800	18,200	19,200	13,800	61,000
Fixed overhead budgeted	18,300	18,300	18,300	18,300	73,200
Total budgeted overhead	28,100	36,500	37,500	32,100	134,200
Less: Depreciation*	4,000	4,000	4,000	4,000	16,000
Cash disbursements for Factory overhead	$24,100	$32,500	$33,500	$28,100	$118,200

*Depreciation does not require a cash outlay.

THE ENDING FINISHED GOODS INVENTORY BUDGET

The ending finished goods inventory budget provides us with the information required for the construction of budgeted financial statements. After completing Schedules 1-5, sufficient data will have been generated to compute the per-unit manufacturing cost of finished product. This computation is required for two reasons: (1) to help compute the cost of goods sold on the budgeted income statement; and (2) to give the dollar value of the ending finished goods inventory to appear on the budgeted balance sheet.

SCHEDULE 6

THE PUTNAM COMPANY

Ending Finished Goods Inventory Budget

Ending inventory Units	Unit Product Cost	Total
300 units (Sch. 2)	$82*	$24,600

*The unit product cost of $82 is computed as follows

	Unit cost	Units	Total
Direct Materials	$ 5 per lbs.	2 pounds	$10
Direct labor	10 per hr.	5 hours	50
Factory overhead**	4.40 per hr.	5 hours	22
Unit product cost			$82

** Predetermined factory overhead applied rate = Budgeted annual factory overhead/budgeted annual activity units = $134,200/30,500 DLH = $4.40 (see Chapter 3; Cost Accounting Systems – Job Order Costing).

THE SELLING AND ADMINISTRATIVE EXPENSE BUDGET

The selling and administrative expense budget lists the operating expenses involved in selling the products and in managing the business. Just as in the case of the factory overhead budget, this budget can be developed using the coat-volume (*flexible budget)* formula in the form of y = a + bx.

If the number of expense items is very large, separate budgets may be needed for the selling and administrative functions.

SCHEDULE 7

THE PUTNAM COMPANY
Selling and Administrative Expense Budget
For the Year Ended December 31, 20B

	QUARTER				
	1	2	3	4	Year as a Whole
Expected sales in units	1,000	1,800	2,000	1,200	6,000
Variable selling and administrative expense per unit*	x $3	x $3	x $3	x $3	x $3
Budgeted variable expense	$3,000	$5,400	$6,000	$3,200	$18,000
Fixed selling and administrative expense**:					
Advertising	20,000	20,000	20,000	20,000	80,000
Insurance		12,600			12,600
Office salaries	40,000	40,000	40,000	40,000	160,000
Taxes				7,400	7,400
Total budgeted selling and Administrative expenses***	$63,000	$78,000	$66,000	$71,000	$278,000

* Assumed. It includes sales agents' commissions, shipping, and supplies.
** Scheduled to be paid.
*** Paid for in the quarter incurred.

THE CASH BUDGET

The cash budget is prepared for the purpose of cash planning and control. It presents the expected cash inflow and outflow for a designated time period. The cash budget helps management keep cash balances in reasonable relationship to its needs. It aids in avoiding unnecessary idle cash and possible cash shortages. The cash budget consists typically of four major sections:

1. The *cash receipts* section, which is cash collections from customers and other cash receipts such as royalty income and investment income.

2. The *cash disbursements* section, which comprises all cash payments made by purpose.

3. The *cash surplus* or *deficit* section, which simply shows the difference between the total cash available and the total cash needed including a *minimum cash balance* if required. If there is surplus cash, loans may be repaid or temporary investments made.

4. The *financing* section, which provides a detailed account of the borrowings, repayments, and interest payments expected during the budgeting period.

   The *investments* section, which encompasses investment of excess cash and liquidation of investment of surplus cash.

SCHEDULE 8

To illustrate, we will make the following assumptions:

- Putnam Company has an open line of credit with its bank, which can be used as needed to bolster the cash position.
- The company desires to maintain a $10,000 minimum cash balance at the end of each quarter. Therefore, borrowing must be sufficient to cover the cash shortfall and to provide for the minimum cash balance of $10,000
- All borrowings and repayments must be in multiples of $1,000 amounts, and interest is 10 percent per annum.
- Interest is computed and paid on the principal as the principal is repaid.
- All borrowings take place at the beginning of a quarter, and all repayments are made at the end of a quarter.
- No investment option is allowed in this example. The loan is *self-liquidating* in the sense that the borrowed money is used to obtain resources that are combined for sale, and the proceeds from sales are used to pay back the loan.

Note: To be useful for cash planning and control, the cash budget must be prepared on a *monthly* basis.

Note the following:

Cash balance, beginning
<u>Add receipts:</u>
  Total cash available before financing (a)
<u>Deduct disbursements:</u>
  Total cash disbursements (b)
<u>+ Minimum cash balance desired</u>
  Total cash needed (c)
<u>Cash surplus or deficit (a) – (c)</u>
Financing:
  Borrowing (at beginning)
  Repayment (at end)
  Interest
<u> Total effects of financing (d)</u>
Cash balance, ending [(a) – (b) + (d)]

YOU SHOULD REMEMBER

Cash balance, ending [(a) – (b) + (d)]

= Total cash available – total cash disbursements

+ total effects of financing

THE PUTNAM COMPANY
Cash Budget
For the Year Ended December 31, 20B

	From Schedule	QUARTER 1	2	3	4	Year as a Whole
Cash balance, beginning		$19,000*	10,675	10,000	10,350	19,000
Add: **Receipts**:						
Collections from customers	1	160,000	198,000	282,000	252,000	892,000
Total cash available (a)		179,000	208,675	292,000	262,350	911,000
Less: **Disbursements:**						
Direct materials	3	12,225	15,175	18,150	15,400	60,950
Direct labor	4	49,000	91,000	96,000	69,000	305,000
Factory overhead	5	24,100	32,500	33,500	28,100	118,200
Selling and Admin.	7	63,000	78,000	66,000	71,000	278,000
Equipment purchase	Given	30,000	12,000	0	0	42,000
Dividends	Given	5,000	5,000	5,000	5,000	20,000
Income tax	10	15,000	15,000	15,000	15,000	60,000
Total disbursements (b)		198,325	248,675	233,650	203,500	884,150
Minimum cash balance		10,000	10,000	10,000	10,000	10,000
Total cash needed (c)		208,325	258,675	243,650	213,500	894,150
Cash surplus (deficit) (a) – (c)		(29,325)	(50,000)	48,350	48,850	16,850
Financing:						
Borrowing		30,000**	50,000	0	0	80,000
Repayment		0	0	(45,000)	(35,000)	(80,000)
Interest		0	0	(3,000)***	(2,625)+	(5,625)
Total effects of financing (d)		30,000	50,000	(48,000)	(37,625)	(5,625)
Cash balance, ending [(a) – (b) + (d)]		$10,675	10,000	10,350	21,225	$21,225

* $19,000 (from the balance sheet 20A).

** The company desires to maintain a $10,000 minimum cash balance at the end of each quarter. Therefore, borrowing must be sufficient to cover the cash shortfall of $19,325 and to provide for the minimum cash balance of $10,000, for a total of $29,325.

*** The interest payments relate only to the principal being repaid at the time it is repaid. For example, the interest in quarter 3 relates only to the interest due on the $30,000 principal being repaid from quarter 1 borrowing and on the $15,000 principal being repaid from quarter 2 borrowing. Total interest being paid is $3,000, shown as follows:

$30,000 x 10% x 3/4 = $2,250
$15,000 x 10% x 2/4 = 750

\+ $35,000 x 10% x 3/4 = $2,625

THE BUDGETED INCOME STATEMENT

The budgeted income statement summarizes the various component projections of revenue and expenses for the budgeting period. However, for control purposes the budget can be divided into quarters or even months depending on the need.

SCHEDULE 9

THE PUTNAM COMPANY
Budgeted Income Statement
For the Year Ended December 31, 20B

	From Schedule			
Sales (6,000 units) @$150)	1		$900,000	
Less: Cost of goods sold				
Beginning finished goods inventory	10	$16,400		
Add: Cost of goods manufactured				
(6,100 units @$82)*	6	500,200		
Cost of goods available for sale		516,600		
Less: Ending finished goods inventory	6	(24,600)	492,200	
Gross margin			408,000	
Less: Selling and administrative expenses	7		278,000	
Operating income			130,000	
Less: Interest expense	8		5,625	
Net income before taxes			124,375	
Less: Income taxes			60,000	**
Net income after taxes			$64,365	

* From Chapter 2, *cost of goods manufactured* = total manufacturing cost + beginning work in process inventory - ending work in process inventory. Since there are no work in process inventories in this illustration, cost of goods manufactured = total manufacturing cost. Thus
cost of goods manufactured = direct materials used + direct labor + factory overhead = $61,000 (12,200 ibs. @$5 per ibs.—Schedule 3) + $305,000 (Schedule 4) + $134,200 (Schedule 5) = $500,200
**Estimated

THE BUDGETED BALANCE SHEET

The budgeted balance sheet is developed by beginning with the balance sheet for the year just ended and adjusting it, using all the activities that are expected to take place during the budgeting period. Some of the reasons why the budgeted balance sheet must be prepared are:

• It could disclose some unfavorable financial conditions that management might want to avoid.

• It serves as a final check on the mathematical accuracy of all the other schedules.

• It helps management perform a variety of ratio calculations.

• It highlights future resources and obligations.

We can construct the budgeted balance sheet by using :

♦ The December, 20A balance sheet (Schedule 10)

♦ The cash budget (Schedule 8)

♦ The budgeted income statement (Schedule 9).

Putnam's budgeted balance sheet for December 31, 20B, is presented below. Supporting calculations of the individual statement accounts are also provided.

SCHEDULE 10

To illustrate, we will use the following balance sheet for the year 20A.

THE PUTNAM COMPANY
Balance Sheet
December 31, 20A

Assets		
Current assets:		
Cash	$ 19,000	
Accounts receivable	100,000	
Materials inventory (490 lbs.)	2,450	
Finished goods inventory (200 units)	16,400	
Total current assets		$137,850
Plant and equipment:		
Land	30,000	
Buildings and equipment	250,000	
Accumulated depreciation	(74,000)	
Plant and equipment, net		206,000
Total assets		$343,850
Liabilities and Stockholders' Equity		
Current liabilities		
Accounts payable (raw materials)	$ 6,275	
Income tax payable	60,000	
Total current liabilities		$66,275
Stockholders' equity:		
Common stock, no par	$200,000	
Retained earnings	77,575	
Total stockholders' equity		277,575
Total liabilities and stockholders' equity		$343,850

THE PUTNAM COMPANY Balance Sheet December 31, 20B			
Assets			
Cash	$ 21,225	(a)	
Accounts receivable	108,000	(b)	
Materials inventory (520 lbs.)	2,600	(c)	
Finished goods inventory (300 units)	24,600	(d)	
Total current assets			$156,425
Plant and equipment:			
Land	30,000	(e)	
Buildings and equipment	292,000	(f)	
Accumulated depreciation	(90,000)	(g)	
Plant and equipment, net			232,000
Total assets			$388,425
Liabilities and Stockholders' Equity			
Current liabilities			
Accounts payable (raw materials)	$ 6,475	(h)	
Income tax payable	60,000	(i)	
Total current liabilities			$66,475
Stockholders' equity:			
Common stock, no par	$200,000	(j)	
Retained earnings	121,950	(k)	
Total stockholders' equity			321,950
Total liabilities and stockholders' equity			$388,425

Supporting computations:

a. From Schedule 8 (cash budget).
b. $100,000 (Accounts receivable, 12/31/20A) + $900,000 (Credit sales from Schedule 1) - $892,000(Collections from Schedule 1) = $108,000, *or* 60% of 4th quarter credit sales, from Schedule 1 ($180,000 x 60% = $108,000).
c. Direct materials, ending inventory = 520 pounds x $ 5 = $2,600 (From Schedule 3)
d. From Schedule 6 (ending finished goods inventory budget).
e. From the 20A balance sheet and Schedule 8 (no change).
f. $250,000 (Building and Equipment, 12/31/20A) + $42,000 (purchases from Schedule 8) = $292,000.
g. $74,000 (Accumulated Depreciation, 12/31/20A) + $16,000 (depreciation expense from Schedule 5) = $90,000.

h. Note that all accounts payable relate to material purchases. $6,275 (Accounts payable, 12/31/20A) + $61,150 (credit purchases from Schedule 3) - $60,950 (payments for purchases from Schedule 3) = $6,475, *or* 50% of 4th quarter purchase = 50% ($12,950) = $6,475.
i. From Schedule 9.
j. From the 20A balance sheet and Schedule 8 (no change).
k. $77,575 (Retained earnings, 12/31/20A) + $64,375 (net income for the period, Schedule 9) – $20,000 (cash dividends from Schedule 8) = $121,950.

SOME FINANCIAL CALCULATIONS

To see what kind of financial condition the Putnam Company is expected to be in for the budgeting year, a sample of financial ratio calculations are in order: (Assume 20A after-tax net income was $45,000)

	20A	**20B**
Current ratio:		
(Current assets/ current liabilities)	$137,850/$66,275	$156,425/$66,475
	=2.08	=2.35
Return on total assets:		
(net income after taxes / total assets)	$45,000/$343,850	$64,375/$388,425
	=13.08%	=16.57%

Sample calculations indicate that the Putnam Company is expected to have better liquidity as measured by the current ratio. Overall performance will be improved as measured by return on total assets. This could be an indication that the contemplated plan may work out well.

FINANCIAL MODELING:
COMPUTER – BASED AND SPREAD SHEET MODELS FOR BUDGETING

More and more companies are developing computer-based models for financial planning and budgeting, using powerful, yet easy-to-use, financial modeling languages such as Centage's *Budget Maestro* and *Up Your Cash Flow*. The models help not only build a budget for profit planning but answer a variety of "what-if" scenarios. The resultant calculations provide a basis for choice among alternatives under conditions of uncertainty. Furthermore, budget modeling can also be accomplished using spreadsheet programs such as *Microsoft's Excel*.

In this section we will illustrate the use of *Excel* to develop a financial model. For illustrative purposes, we will present three examples of projecting an income statement.

Case 1

Sales for 1st month = \$60,000
Cost of sales = 42% of sales, all variable
Operating expenses = \$10,000 fixed plus 5% of sales
Taxes = 30% of net income
Sales increase by 5% each month

1.. Based on this information, Figure 2 presents a spreadsheet for the contribution income statement for the next 12 months and in total.

2. Figure 3 shows the same in (1) assuming that sales increase by 10% and operating expenses = \$10,000 plus 10% of sales. This is an example of “what-if” scenarios.

Figure 2
PROJECTED INCOME STATEMENT

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*TOTAL*	*PERCENT*
Sales	$60,000	$63,000	$66,150	$69,458	$72,930	$76,577	$80,406	$84,426	$88,647	$93,080	$97,734	$102,620	$955,028	100%
Less: VC														
Cost of sales	$25,200	$26,460	$27,783	$29,172	$30,631	$32,162	$33,770	$35,459	$37,232	$39,093	$41,048	$43,101	$401,112	42%
Operating ex.	$3,000	$3,150	$3,308	$3,473	$3,647	$3,829	$4,020	$4,221	$4,432	$4,654	$4,887	$5,131	$47,751	5%
CM	$31,800	$33,390	$35,060	$36,812	$38,653	$40,586	$42,615	$44,746	$46,983	$49,332	$51,799	$54,389	$506,165	53%
Less: FC														
Op. expenses	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$120,000	13%
Net income	$21,800	$23,390	$25,060	$26,812	$28,653	$30,586	$32,615	$34,746	$36,983	$39,332	$41,799	$44,389	$386,165	40%
Less: Tax	$6,540	$7,017	$7,518	$8,044	$8,596	$9,176	$9,785	$10,424	$11,095	$11,800	$12,540	$13,317	$115,849	12%
NI after tax	$15,260	$16,373	$17,542	$18,769	$20,057	$21,410	$22,831	$24,322	$25,888	$27,533	$29,259	$31,072	$270,315	28%

Figure 3
PROJECTING INCOME STATEMENT

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*TOTAL*	*PERCENT*
Sales	$60,000	$66,000	$72,600	$79,860	$87,846	$96,631	$106,294	$116,923	$128,615	$141,477	$155,625	$171,187	$1,283,057	134%
Less: VC														
Cost of sales	$25,200	$27,720	$30,492	$33,541	$36,895	$40,585	$44,643	$49,108	$54,018	$59,420	$65,362	$71,899	$538,884	56%
Operating ex.	$6,000	$6,600	$7,260	$7,986	$8,785	$9,663	$10,629	$11,692	$12,862	$14,148	$15,562	$17,119	$64,153	7%
CM	$28,800	$31,680	$34,848	$38,333	$42,166	$46,383	$51,021	$56,123	$61,735	$67,909	$74,700	$82,170	$615,867	64%
Less: FC														
Op. expenses	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$120,000	13%
Net income	$18,800	$21,680	$24,848	$28,333	$32,166	$36,383	$41,021	$46,123	$51,735	$57,909	$64,700	$72,170	$495,867	52%
Less: Tax	$5,640	$6,504	$7,454	$8,500	$9,650	$10,915	$12,306	$13,837	$15,521	$17,373	$19,410	$21,651	$148,760	16%
NI after tax	$13,160	$15,176	$17,394	$19,833	$22,516	$25,468	$28,715	$32,286	$36,215	$40,536	$45,290	$50,519	$347,107	36%

Case 2

Delta Gamma Company wishes to prepare a three-year projection of net income using the following information:

1. 2006 base year amounts are as follows:

Sales revenues	$4,500,000
Cost of sales	2,900,000
Selling and administrative expenses	800,000
Net income before taxes	800,000

2. Use the following assumptions:

- Sales revenues increase by 6% in 2007, 7% in 2008, and 8% in 2009.
- Cost of sales increase by 5% each year.
- Selling and administrative expenses increase only 1% in 2006 and will remain at the 2007 level thereafter.
- Income tax rate = 46%

Figure 4 presents a spreadsheet for the income statement for the next three years.

FIGURE 4

Delta Gamma Company
Three-Year Income Projections (2006-2009)

	2006	***2007***	***2008***	***2009***
Sales	$4,500,000	$4,770,000	$5,103,900	$5,512,212
Cost of sales	2,900,000	3,045,000	3,197,250	3,357,113
Gross margin	1,600,000	1,725,000	1,906,650	2,155,100
Selling & adm. Exp.	800,000	808,000	808,000	808,000
Net income before tax	800,000	917,000	1,098,650	1,347,100
Tax	368,000	421,820	505,379	619,666
Net income after tax	$ 432,000	$ 495,180	$ 593,271	$ 727,434

ZERO BASE BUDGETING

The traditional budgeting techniques involve adding or subtracting a given percentage increase or decrease to the preceding period's budget and arriving at a new budget. The prior period's costs are considered to be basic and the emphasis is usually placed on what upward revisions are to be made for the upcoming year. The traditional method focuses on inputs rather than outputs related to goal achievement and as such never calls for the evaluation of corporate activities from a cost/benefit perspective.

Zero-Base Budgeting (ZBB) can generally be described as a technique which requires each manager to justify his entire budget request in detail from a base of zero and as such asks for an analysis of the output values of each activity of a particular cost/responsibility center. This approach requires that all activities under scrutiny be defined in decision packages which are to be evaluated and ranked in order of importance at various levels. As an end product, a body of structured data is obtained that enables management to allocate funds confidently to the areas of greatest potential gain.

ZBB is most applicable in planning service and support expenses rather than direct manufacturing expenses. This technique is best suited to operations and programs over which management has some discretion. For example, it can be used to develop:

- Administrative and General Support
- Marketing
- Research
- Engineering
- Manufacturing Support
- Capital Budgets

It should not be used for:

- Direct labor
- Direct material
- Factory overhead

which are usually budgeted through various methods discussed in the previous section. Figure 5 helps our understanding of ZBB by indicating the key differences between ZBB and traditional (incremental) budgeting systems.

FIGURE 5
DIFFERENCES BETWEEN TRADITIONAL AND ZERO BUDGETING

Traditional	*Zero Base*
Starts from existing base	Starts with Base Zero
Starts with dollars	Starts with purposes and activities
Does not examine new ways of operating as integral part of process	Explicitly examines new approaches
Results in a non-alternative budget	Results in a choice of several levels of service and cost

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CHAPTER SUMMARY

A budget is a detailed quantitative plan outlining the acquisition and use of financial and other resources of an organization over some given time period. It is a tool for planning. If properly constructed, it is used as a control device. This chapter showed, step-by-step, how to formulate a master budget. The process begins with the development of a sales budget and proceeds through a number of steps that ultimately lead to the cash budget, the budgeted income statement, and the budgeted balance sheet.

In recent years computer-based models and spreadsheet software have been utilized for budgeting in an effort to speed up the budgeting process and allow managerial accountants to investigate the effects of changes in budget assumptions.

Zero-base budgeting (ZBB) has received considerable attention recently as a new approach to budgeting, particularly for use in nonprofit, governmental, and service-type organizations. The chapter discussed the pros and cons of ZBB.

CHAPTER 8
RESPONSIBILITY ACCOUNTING, STANDARD COSTS, AND VARIANCES

Responsibility accounting is the system for collecting and reporting revenue and cost information by areas of responsibility. It operates on the premise that managers should be held responsible for their performance, the performance of their subordinates, and all activities within their responsibility center. Responsibility accounting, also called profitability accounting and activity accounting, has the following advantages:

1. It facilitates delegation of decision making.

2. It helps management promote the concept of management by objective. In management by objective, managers agree on a set of goals. The manager's performance is then evaluated based on his or her attainment of these goals.

3. It provides a guide to the evaluation of performance and helps to establish standards of performance which are then used for comparison purposes.

4. It permits effective use of the concept of management by exception, which means that the manager's attention is concentrated on the important deviations from standards and budgets.

After studying the material in this chapter, you will be able to

- Define responsibility accounting and state how important it is for managerial control.

- Distinguish among three types of responsibility centers and see how they are evaluated.

- Calculate different types of variances for manufacturing costs--direct materials, direct labor, and manufacturing overhead.

- Explain the managerial significance of these variances.

- Prepare a flexible budget and explain its advantage over the static budget format.

- Calculate and properly interpret the fixed overhead spending and volume variances.

- Distinguish among the two-way, three-way, and four-way variance analysis for factory overhead.

RESPONSIBILITY ACCOUNTING AND RESPONSIBILITY CENTER

For an effective responsibility accounting system, the following three basic conditions are necessary:

(a) The organization structure must be well defined. Management responsibility and authority must go hand in hand at all levels and must be clearly established and understood.

(b) Standards of performance in revenues, costs, and investments must be properly determined and well defined.

(c) The responsibility accounting reports (or performance reports) should include only items that are controllable by the manager of the responsibility center. Also, they should highlight items calling for managerial attention.

A well-designed responsibility accounting system establishes responsibility centers within the organization. A responsibility center is defined as a unit in the organization which has control over costs, revenues, and/or investment funds. Responsibility centers can be one of the following types:

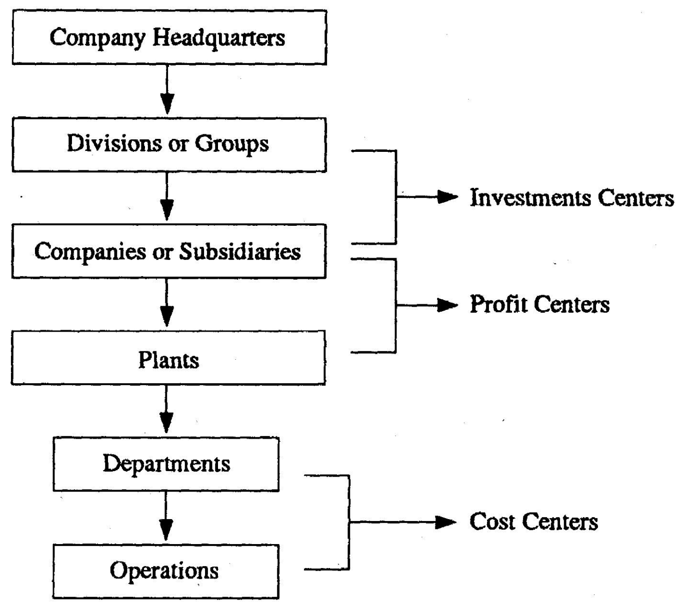
Cost center. A cost center is the unit within the organization which is responsible only for costs. Examples include production and maintenance departments of a manufacturing company. ***Variance analysis*** based on standard costs and flexible budgets would be a typical performance measure of a cost center.

Profit center. A profit center is the unit which is held responsible for the revenues earned and costs incurred in that center. Examples might include a sales office of a publishing company, and appliance department in a retail store, and an auto repair center in a department store. The *contribution approach* to cost allocation is widely used to measure the performance of a profit center. This topic is covered in Chapter 9 (Control of Profit Centers).

Investment center. An investment center is the unit within the organization which is held responsible for the costs, revenues, and related investments made in that center. The corporate headquarters or division in a large decentralized organization would be an example of an investment center.

Figure 1 illustrates the manners in which responsibility accounting can be used within an organization and highlights profit and cost centers. This chapter discusses in detail how the performance of both cost and profit centers are evaluated. Performance evaluation of the investment center is reserved until Chapter 10 (Performance Measurement, Balanced Scorecard, and Transfer Pricing).

FIGURE 1
RESPONSIBILITY CENTERS


Company Headquarters
Divisions or Groups
Companies or Subsidiaries
Plants
Departments
Operations
Investments Centers
Profit Centers
Cost Centers

STANDARD COSTS AND VARIANCE ANALYSIS

One of the most important phases of responsibility accounting is establishing standard costs and evaluating performance by comparing actual costs with the standard costs. *Standard costs* are costs that are established in advance to serve as targets to be met and after the fact, to determine how well those targets were actually met. The standard cost is based on physical and dollar measures: it is determined by multiplying the standard quantity of an input by its standard price. A standard cost system can be used in both job-order and process costing systems to isolate variances.

The difference between the actual costs and the standard costs, called the variance, is calculated for individual cost centers. Variance analysis is a key tool for measuring performance of a cost center.

The *performance reports* based on the analysis of variances must be prepared for each cost center, addressing the following questions:

1. Is it favorable (F) or unfavorable (U)?

2. If it is unfavorable, is it significant enough for further investigation? For example, a 5% over the standard is a redflag. The decision to investigate is based on the company's policy in terms of the standard plus or minus an allowable control limit. Current practice sets the control limits subjectively, based on judgment and past experience rather than any formal identification of limits. About 45 to 47 percent of the firms surveyed used dollar or percentage control limits.

3. If it is significant, is it controllable? For example, it may be due to a strike on the part of the supplier. A material shortage and the ensuing price hike may not be within the control of the production manager.

4. If it is controllable, then who is responsible for what portion of the total variance?

5. What are the causes for an unfavorable variance?

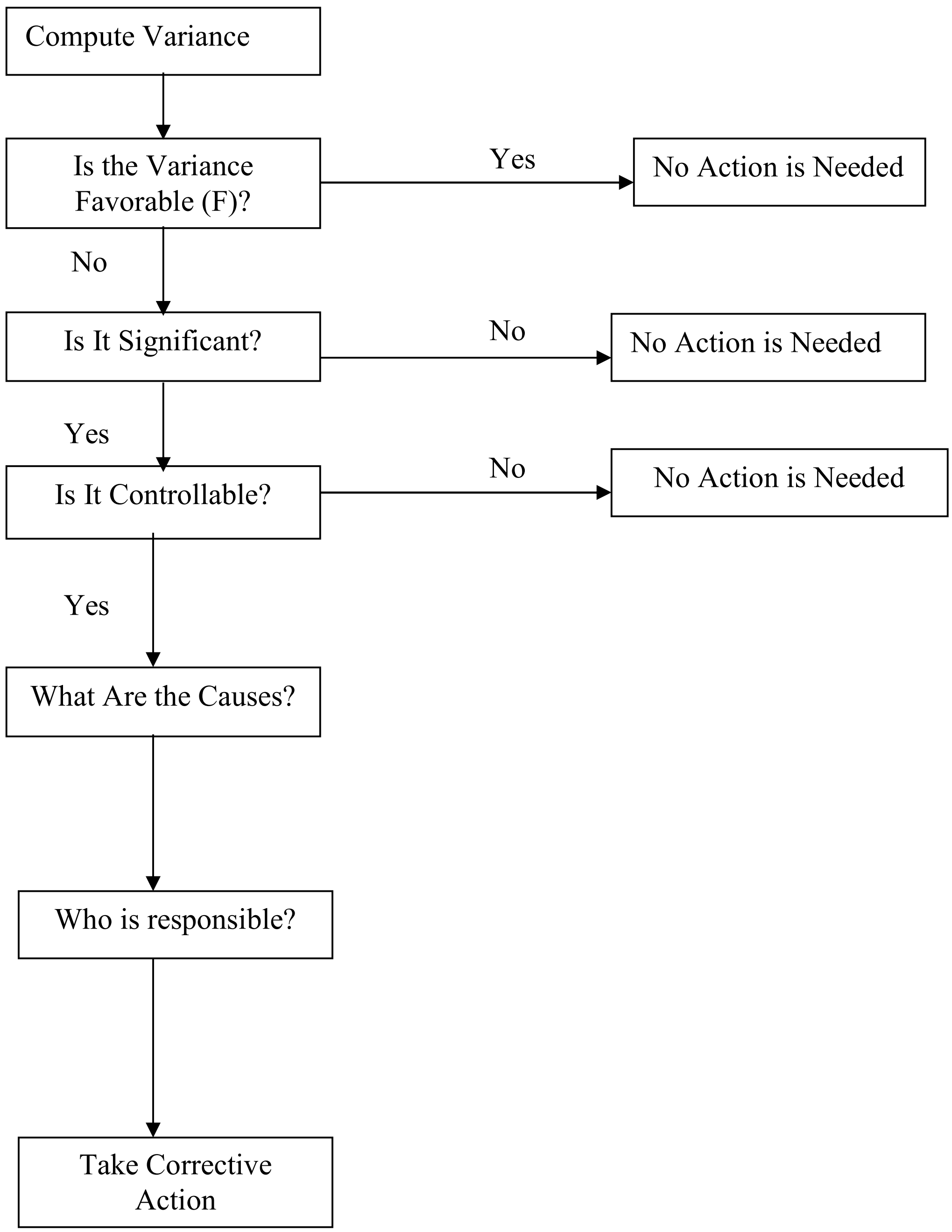
6. What is the remedial action to take?

The whole purpose of variance analysis is to determine what happened, what the causes are, and make sure the same thing does not happen again. The report is useful in two ways: (1) in focusing attention on situations in need of management action and (2) in increasing the precision of planning and control of costs. The report should be produced as part of the overall standard costing and responsibility accounting system.

Figure 2 takes you, step by step, through variance analysis.

FIGURE 2

USING VARIANCE ANALYSIS TO CONTROL COSTS



GENERAL MODEL FOR VARIANCE ANALYSIS

Two general types of variances can be calculated for most cost items: a *price* (rate, spending) variance and a *quantity* (usage, efficiency) variance.

The price variance is calculated as follows:

Price Variance = Actual Quantity x (Actual price - Standard price)

= AQ x (AP - SP)

= (AQ x AP) - (AQ x SP)
(1) (2)

The quantity variance is calculated as follows:

Quantity Variance = (Actual Quantity - Standard Quantity) x Standard Price

= (AQ - SQ) x SP

= (AQ x SP) - (SQ x SP)

(2) (3)

Figure 2 shows a general model (3-column model) for variance analysis that incorporates items (1), (2), and (3) from the above equations.

FIGURE 2

A GENERAL MODEL FOR VARIANCE ANALYSIS OF VARIABLE MANUFACTURING COSTS

Actual Quantity of Inputs at Actual Price **(AQ x AP)** (1)	Actual Quantity of Inputs, at Standard Price **(AQ x SP)** (2)	Standard Quantity Allowed for Output, at Standard Price **(SQ x SP)** (3)

Price Variance (1) – (2)

Quantity Variance (2) – (3)

Total (Flexible Budget) Variance (1) - (3)

- Direct materials purchase Price variance
- Direct labor rate variance
- Variable overhead spending variance

- Direct materials quantity (usage) variance
- Direct labor efficiency variance
- Variable overhead efficiency variance

It is important to note four things:

1. A price variance and a quantity variance can be calculated for all three variable cost items—direct materials, direct labor, and the variable portion of factory overhead. The variance is not called by the same name, however. For example, a price variance is called a materials price variance in the case of direct materials, but a labor rate variance in the case of direct labor and a variable overhead spending variance in the case of variable factory overhead.

2. A cost variance is unfavorable (U) if the actual price AP or actual quantity AQ exceeds the standard price SP or standard quantity SQ; a variance is favorable (F) if the actual price or actual quantity is less than the standard price or standard quantity.

3. The standard quantity allowed for output—item (3)—is the key concept in variance analysis. This is the standard quantity that should have been used to produce actual output. It is computed by multiplying the actual output by the number of input units allowed.

4. Variances for fixed overhead are of questionable usefulness for control purposes, since these variances are usually beyond the control of the production department.

We will now illustrate the variance analysis for each of the variable manufacturing cost items.

MATERIALS VARIANCES

A materials purchase price variance is isolated at the time of purchase of the material. It is computed based on the actual quantity purchased. The purchasing department is responsible for any materials price variance that might occur. The materials quantity (usage) variance is computed based on the actual quantity used. The production department is responsible for any materials quantity variance.

Unfavorable price variances may be caused by: inaccurate standard prices, inflationary cost increases, scarcity in raw material supplies resulting in higher prices, and purchasing department inefficiencies. Unfavorable material quantity variances may be explained by poorly trained workers, by improperly adjusted machines, or by outright waste on the production line. Table 1 provides the reasons and responsible parties for unfavorable materials variance.

EXAMPLE 1

Mighty Kings Corporation uses a standard cost system. The standard variable costs for product J are as follows:

Direct materials: 2 pounds per unit at $3 per pound ($6 per unit of Product J)
Direct labor: 1 hour per unit at $5 per hour ($5 unit of Product J)
Variable overhead: 1 hour per unit at $3 per hour ($3 per unit of Product J)

During March, 25,000 pounds of material were purchased for $74,750 and 20,750 pounds of material were used in producing 10,000 units of finished product. Direct labor costs incurred were $49,896 (10,080 direct labor hours) and variable overhead costs incurred were $34,776.

Using the general model (3-column model), the materials variances are shown in Figure 3.

TABLE 1
REASONS AND RESPONSIBLE PARTIES FOR UNFAVORABLE MATERIALS VARIANCE

Reason	Responsible Party
Overstated price paid, failure to take discounts, improper specifications, insufficient quantities, use of a lower-grade material purchased to economize on price, uneconomical size of purchase orders, failure to obtain an adequate supply of a needed variety, purchase at an irregular time, or sudden and unexpected purchase required	Purchasing
Poor mix of materials, poorly trained workers, improperly adjusted machines, substitution of nonstandard materials, poor production scheduling, poor product design or production technique, lack of proper tools or machines, carelessness in not returning excess materials to storeroom, or unexpected volume changes	Production manager
Failure to detect defective goods	Receiving
Inefficient labor, poor supervision, or waste on the production line	Foreman
Inaccurate standard price	Budgeting
Excessive transportation charges or too small a quantity purchased	Traffic management
Insufficient quantity bought because of a lack of funds	Financial

FIGURE 3
MATERIALS VARIANCES

Actual Quantity of Inputs at Actual Price **(AQ x AP)** **(1)**	Actual Quantity of Inputs, at Standard Price **(AQ x SP)** **(2)**	Standard Quantity Allowed for Output, at Standard Price **(SQ x SP)** **(3)**
25,000 lb x $2.99* = $74,750	25,000 lb x $3.00 =$75,000	20,000 lb**x $3.00 =$60,000

Price Variance, $250 (F)

20,750 lb x $3.00
= $62,250

Quantity Variance, 2,250 (U)

---

*$74,750/25,000 ibs. = $2.99
**10,000 units actually produced * 2 pounds allowed per unit = 20,000 pounds.

It is important to note that the amount of materials purchased (25,000 pounds) differs from the amount of materials used in production (20,750 pounds). The materials purchase price variance was computed using 25,000 pounds purchased, whereas the materials quantity (usage) variance was computed using the 20,750 pounds used in production. A total variance cannot be computed because of the difference.

Alternatively, we can compute the materials variances as follows:

Materials purchase price variance = AQ (AP - SP)
= (AQ x AP) - (AQ x SP)
= (25,000 pounds) ($2.99 - $3.00)
= $74,750 - $75,000
$250 (F)

Materials quantity usage variance = (AQ - SQ) SP
= (20,750 pounds - 20,000 pounds) ($3.00)
= $62,250 - $60,000
= $74,750 - $75,000
= $2,250 (U)

LABOR VARIANCES

Labor variances are isolated when labor is used for production. They are computed in a manner similar to the materials variances, except that in the 3-column model the terms efficiency and rate are used in place of the terms quantity and price. The production department is responsible for both the prices paid for labor services and the quantity of labor services used. Therefore, the production department must explain why any labor variances occur.

Unfavorable rate variances may be explained by an increase in wages, or the use of labor commanding higher wage rates than contemplated. Unfavorable efficiency variances may be explained by poor supervision, poor quality workers, poor quality of materials requiring more labor time, machine breakdowns, and employee unrest. Table 2 provides the reasons and responsible parties for unfavorable labor variance.

TABLE 2
REASON AND RESPONSIBLE PARTIES FOR AN UNFAVORABLE LABOR VARIANCE.

Reason	Responsible Party
Use of overpaid or excessive number of workers	Production manager or union contract
Poor job descriptions or excessive wages	Personnel
Overtime and poor scheduling of production	Production planning
Poor-quality workers or poor training	Personnel or Training
Inadequate supervision, inefficient flow of materials, wrong mixture of labor for a given job, inferior tools or idle time from production delays	Foreman
Employee unrest	Personnel or Foreman
Improper functioning of equipment	Maintenance
Insufficient material supply or poor quality	Purchasing

EXAMPLE 2

Using the same data given in Example 1, the labor variances can be calculated as shown in Figure 4.

FIGURE 4
LABOR VARIANCES

Actual Hours of Inputs at Actual Rate **(AH x AR)** **(1)**	Actual Hours of Inputs, at Standard Rate **(AH x SR)** **(2)**	Standard Hours Allowed for Output, at Standard Rate **(SH x SR)** **(3)**
10,080 h x $4.95* = $49,896	10,080 h x $5.00 = $50,400	10,000 h** x $5.00 = $50,000
Rate Variance (1) – (2) $504 (F)	Efficiency Variance (2) – (3) $400 (U)	
Total Variance $104 (F)		

*$49,896/10,080 h = $4.95
** 10,000 units actually produced * 1 hour (h) allowed per unit = 10,000 hours.

Note: The symbols AQ, SQ, AP, and SP have been changed to AH, SH, AR, and SR to reflect the terms "hour" and "rate".

Alternatively, we can calculate the labor variances as follows:

Labor rate variance = AH (AR - SR)
= (AH x AR) - (AH x SR)
= (10,080 hours) ($4.95 - $5.00)
= $49,896 - $50,400
= $504 (F)

Labor efficiency variance = (AH - SH) SR
= (10,080 hours - 10,000 hours) x $5.00
= $50,400 - $50,000
= $400 (U)

VARIABLE OVERHEAD VARIANCES

The variable overhead variances are computed in a way very similar to the labor variances. The production department is usually responsible for any variable overhead variance.

Unfavorable variable overhead spending variances may be caused by a large number of factors: acquiring supplies for a price different from the standard, using more supplies than expected, waste, and theft of supplies. Unfavorable variable overhead efficiency variances might be caused by such factors as: poorly trained workers, poor-quality materials, faulty equipment, work interruptions, poor production scheduling, poor supervision, employee unrest, and so on.

When variable overhead is applied using direct labor hours, the efficiency variance will be caused by the same factors that cause the labor efficiency variance. However, when variable overhead is applied using machine hours, inefficiency in machinery will cause a variable overhead efficiency variance.

EXAMPLE 3

Using the same data given in Example 1, the variable overhead variances can be computed as shown in Figure 5.

Alternatively, we can compute the variable overhead variances as follows:

Variable overhead spending variance	= AH (AR - SR)
	= (AH x AR) - (AH x SR)
	= (10,080 hours) ($3.45 - $3.00)
	= $34,776 - $30,240
	= $4,536 (U)

Variable overhead spending variance	= (AH - SH) SR
	= (10,080 hours - 10,000 hours) x $3.00
	= $30,240 - $30,000
	= $240 (U)

FIGURE 5
VARIABLE OVERHEAD VARIANCES

Actual Hours of Inputs at Actual Rate **(AH x AR)** **(1)**	Actual Hours of Inputs, at Standard Rate **(AH x SR)** **(2)**	Standard Hours Allowed for Output, at Standard Rate **(SH x SR)** **(3)**
10,080 h x $3.45* = $34,776	10,080 h x $3.00 = $30,240	10,000 h** x $3.00 = $30,000

Spending Variance	Efficiency Variance
(1) – (2)	(2) – (3)
$4,536 (U)	$240 (U)
Total Variance $4,776 (U)	

*$34,776/10,080 h= $3.45
** 10,000 units actually produced * 1 hour (h) allowed per unit = 10,000 hours.

FLEXIBLE BUDGETS AND PERFORMANCE REPORTS

A flexible budget is a tool that is extremely useful in cost control. In contrast to a static budget, which was discussed in Chapter 7 (Budgeting for Profit Planning), the flexible budget is characterized as follows:

1. It is geared toward a range of activity rather than a single level of activity.

2. It is dynamic in nature rather than static. By using the cost-volume formula (or flexible budget formula), a series of budgets can be easily developed for various levels of activity.

The static (fixed) budget is geared for only one level of activity and has problems in cost control. Flexible budgeting distinguishes between fixed and variable costs, thus allowing for a budget which can be automatically adjusted (via changes in variable cost totals) to the particular level of activity actually attained. Thus, variances between actual costs and budgeted costs are adjusted for volume ups and downs before differences due to price and quantity factors are computed.

The primary use of the flexible budget is to accurately measure performance by comparing actual costs for a given output with the budgeted costs for the same level of output.

EXAMPLE 5

To illustrate the difference between the static budget and the flexible budget, assume that the Assembly Department of Omnis Industries, Inc. is budgeted to produce 6,000 units during June. Assume further that the company was able to produce only 5,800 units. The budget for direct labor and variable overhead costs is as follows:

OMNIS INDUSTRIES, INC.
The Direct Labor and Variable Overhead Budget
Assembly Department
For the Month of June

Budgeted production	6,000 units
Actual production	5,800 units
Direct labor	$39,000
Variable overhead costs:	
Indirect labor	6,000
Supplies	900
Repairs	300
	$46,200

If a static budget approach is used the performance report will appear as follows:

OMNIS INDUSTRIES, INC.
DIRECT LABOR AND VARIABLE OVERHEAD
Static Budget Versus Actual
Assembly Department
For the Month of June

	Budget	Actual*	Variance (U or F)**
Production in units	6,000	5,800	200U
Direct labor	$39,000	$38,500	$500F
Variable overhead costs:			
Indirect labor	6,000	5,950	50F
Supplies	900	870	30F
Repairs	300	295	5F
	$46,200	$45,615	$585F

*Given.
**A variance represents the deviation of actual cost from the standard or budgeted cost. U and F stand for "unfavorable" and "favorable," respectively.

These cost variances are useless, in that they are comparing oranges with apples. The problem is that the budget costs are based on an activity level of 6,000 units, whereas the actual costs were incurred at an activity level below this (5,800 units).

From a control standpoint, it makes no sense to try to compare costs at one activity level with costs at a different activity level. Such comparisons would make a production manager look good as long as the actual production is less than the budgeted production. Using the cost-volume formula and generating the budget based on the 5,800 actual units gives the following performance report:

OMNIS INDUSTRIES, INC.
Performance Report Assembly Department
Flexible Budget Versus Actual
For the Month of June

Budgeted production	6,000 units
Actual production	5,800 units

	Cost-volume formula	Flexible Budget 5,800 units	Actual 5,800 units	Variance (U or F)
Direct labor	$6.50 per unit	$37,700	$38,500	$800U
Variable overhead:				
Indirect labor	1.00	5,800	5,950	150U
Supplies	0.15	870	870	0
Repairs	0.05	290	295	5U
	$7.70	$44,660	$45,615	$955U

* assumed
** $6.50 per unit x 5,800 units = $37,700.

Notice that all cost variances are unfavorable (U), as compared to the favorable cost variances on the performance report based on the static budget approach.

FIXED OVERHEAD VARIANCES

By definition, fixed overhead does not change over a relevant range of activity; the amount of fixed overhead per unit varies inversely with the level of production. In order to calculate variances for fixed overhead, it is necessary to determine a standard fixed overhead rate, which requires the selection of a predetermined (denominator) level of activity. This activity should be measured on the basis of standard inputs allowed. The formula is:

$$\text{Standard fixed overhead rate} = \frac{\text{Budgeted fixed overhead}}{\text{Budgeted level of activity}}$$

Total fixed overhead variance is simply under- or over-applied overhead. It is the difference between actual fixed overhead incurred and fixed overhead applied to production (generally, on the basis of standard direct labor hours allowed for actual production). Total fixed overhead variance combines fixed overhead spending (flexible-budget) variance and fixed overhead volume (capacity) variance.

(a) Fixed overhead spending (flexible-budget) variance. It is the difference between actual fixed overhead incurred and budgeted fixed overhead. This variance is not affected by the level of production. Fixed overhead, by definition, does not change with the level of activity. The spending (flexible-budget) variance is caused solely by events such as unexpected changes in prices and unforeseen repairs.

(b) Fixed overhead volume (capacity) variance. This variance results when the actual level of activity differs from the denominator activity used in determining the standard fixed overhead rate. Note that the denominator used in the formula is the expected annual activity level. Fixed overhead volume variance is a measure of the cost of failure to operate at the denominator (budgeted) activity level, and may be caused by such factors as failure to meet sales targets, idleness due to poor scheduling, and machine breakdowns. The volume variance is calculated as follows:

Fixed overhead volume variance = (Budgeted fixed overhead) - (fixed overhead applied)

or

= (Denominator activity - standard hours allowed) x standard fixed overhead rate

When denominator activity exceeds standard hours allowed, the volume variance is unfavorable (U), because it is an index of less-than-denominator utilization of capacity.

There are no efficiency variances for fixed overhead. Fixed overhead does not change regardless of whether productive resources are used efficiently or not. For example, property taxes, insurance and factory rents are not affected by whether production is being carried on efficiently.

Figure 6 illustrates the relationship between the various elements of fixed overhead, and the possible variances.

FIGURE 6

FIXED OVERHEAD VARIANCES

Incurred: Actual Hours x Actual Rate	Flexible Budget Based on Actual Hours	Flexible Budget Based on Standard Hours Allowed	Applied
(1)	**(2)**	**(3)**	**(4)**

<table>
<tr><td>3-way Analysis</td><td>Spending Variance
(1) – (2)</td><td>Efficiency Variance
(Not Applicable)</td><td>Volume Variance
(3) – (4)</td></tr>
<tr><td>2 way Analysis</td><td colspan="2">Flexible Budget Variance
(1) – (3)</td><td>Volume Variance
(3) – (4)</td></tr>
<tr><td></td><td colspan="3">(1) - (4)
Under- or Over-Applied</td></tr>
</table>

EXAMPLE 4

The Doubtfire Manufacturing Company has the following standard cost of factory overhead at a normal monthly production (denominator) volume of 1,300 direct labor hours:

Variable overhead (1 hour @ $2)
Fixed overhead (1 hour @ $5)

Fixed overhead budgeted is $6,500 per month. During the month March, the following events occurred:

(a) Actual overhead costs incurred (for 1,350 hours) were:

Variable	$2,853
Fixed	$6,725

(b) Standard hours allowed, 1,250 hours (1 hour x 1,250 units of output)

Note that:

(a) Flexible budget formula:

Variable overhead rate,	$2 per direct labor hour
Fixed overhead budgeted,	$6,500

(b) Standard overhead applied rates:

Variable,	$2 per direct labor hour
Fixed,	$5 per direct labor hour

Figure 7 shows all the variances for variable overhead as well as fixed overhead.

FIGURE 7

VARIANCE ANALYSIS FOR VARIABLE OVERHEAD AND FIXED OVERHEAD

	Incurred: Actual Hours x Actual Rate (1,350 hrs) **(1)**	Flexible Budget Based on Actual Hours (1,250 hrs) **(2)**	Flexible Budget Based on Standard Hours Allowed (1,250 hrs) **(3)**	Applied (1,350 hrs.) **(4)**
V	$2,853	$2,700(1,350 X $2)	$2,500(1,250 x $2)	$2,500
F	6,725	6,500	6,500	6,250
	$9,578	$9,200	$9,000	$8,750

3-way	Spending Variance (1) – (2) V $153 U F 225 U $378 U	Efficiency Variance (Not Applicable) $200 U Not Applicable $200 U	Volume Variance (3) – (4) Not Applicable $250 U $250 U
2 way	Flexible Budget Variance (1) – (3) V $353 U F 225 U $578 U		Volume Variance (3) – (4) Not Applicable $250 U $250 U
	Under- or Over-Applied (1) - (4) V $353 U F 475 U $828 U		

Alternatively, fixed overhead volume variance can be calculated as follows:

Fixed overhead x volume variance = (Denominator activity - standard hours allowed) x standard fixed overhead rate
= (1,300 hours - 1,250 hours) x $5
= 50 hours x $5 = $250 U

METHODS OF VARIANCE ANALYSIS FOR FACTORY OVERHEAD

Variance analysis for factory overhead consists of a two-, three-, or four-way method of computation, depending on the significance of the variance amounts compared to the cost of analysis. These methods are indicated in Figure 6 and Figure 7.

The two-way analysis computes two variances: budget variance (sometimes called the flexible-budget or controllable variance) and volume variances, which means:

(a) Budget variance = Variable spending variance + Fixed spending (budget) variance
+ Variable efficiency variance

(b) Volume variance = Fixed volume variance

The three-way analysis computes three variances: spending, efficiency, and volume variances.

Therefore,

(a) Spending variance = Variable spending variance + Fixed spending (budget) variance
(b) Efficiency variance = Variable efficiency variance
(c) Volume variance = Fixed volume variance

The four-way analysis includes the following:

(a) Variable spending variance
(b) Fixed spending (budget) variance
(c) Variable efficiency variance
(d) Fixed volume variance

NON FINANCIAL PERFORMANCE MEASURES

Standard costs are widely used in manufacturing, service, and not-for-profit organizations. The list of companies using standards as a method for controlling costs and measuring performance continues to grow. For a firm to improve, managers should encompass nonfinancial (or operational) measures as well as financial measures, especially those that track factors required for world-class status. In an automated environment, labor is a smaller proportion of product cost, often less than 5%. Thus, traditional labor variances are of little value to management. Also, the manufacturing process is more reliable in an automated environment, and the traditional variances tend to be minimal.

The new performance measures tend to be nonfinancial and more subjective than standard costs. Table 1 presents five sets of *nonfinancial performance measures***.** They include statistics for activities such as quality control, on-time delivery, inventory, machine downtime, and material waste. Measures such as *quality control and delivery performance,* are customer oriented. These are useful performance measures in all organizations, particularly service organizations in which the focus is on services, not goods. A general model for measuring the relative success of an activity compares number of successes with total activity volume. For example, delivery performance could be measured as follows.

$$\frac{\text{Number of on-time deliveries}}{\text{Total delivery made}} = \text{delivery success rate}$$

The percentage of external failures may be monitored for quality control.

Others may be production oriented. Reducing *material waste, inventory, and machine downtime* have been shown to improve quality and efficiency. These nonfinancial performance measures and measures of performance using standard costs are not mutually exclusive. Reducing materials waste would eliminate an unfavorable materials usage variance, for example. Measures such as inventory turnover and days of inventory can be used, however. Table 3 illustrates nonfinancial performance measures.

TABLE 3
NONFINANCIAL PERFORMANCE MEASURES

Task	*Objective*
Inventory:	
Inventory levels	Decrease inventory levels
Number of inventoried items	Curtail number of different items
Quality control:	
Number of customer complaints	Reduce complaints
Number of defects	Reduce defects
Delivery performance:	
Delivery success rate	Increase on-time deliveries
Materials waste:	
Scrap and waste as a percentage of total cost	Decrease scrap and waste
Machine downtime:	
Percentage of machine downtime	Reduce downtime

CHAPTER SUMMARY

Variance analysis is essential in the organization for the appraisal of all aspects of the business. This chapter was concerned with the control of cost centers through standard costs. It discussed the basic mechanics of how the two major variances --the price variance and the quantity variance--are calculated for direct materials, direct labor, variable overhead, and fixed overhead. Also presented are the managerial significance of these variances. The idea of flexible budgeting was emphasized in an attempt to correctly measure the efficiency of the cost center. We noted that fixed overhead volume variance has a limited usefulness at the level of a cost center, since only top management has the power to expand or contract fixed facilities.

CHAPTER 9
CONTROL OF PROFIT CENTERS

Segmental reporting is the process of reporting activities of profit centers such as divisions, product lines, or sales territories. The *contribution approach* is valuable for segmented reporting because it emphasizes the cost behavior patterns and the controllability of costs that are generally useful for profitability analysis of various segments of an organization.

After studying the material in this chapter, you will be able to

- Describe how costs are allocated to segments of an organization.

- Distinguish between direct fixed costs and common fixed costs.

- Calculate the segment margin and explain how it differs from the contribution margin.

- Prepare a segmental report using the contribution approach.

- Analyze changes in profit by calculating profit variances.

SEGMENTAL REPORTING FOR PROFIT CENTERS

The contribution approach is based on the thesis that:

(1) Fixed costs are much less controllable than variable costs.

(2) *Direct* fixed costs and *common* fixed costs must be clearly distinguished. Direct fixed costs are those fixed which can be identified directly with a particular segment of an organization, whereas common fixed costs are those costs which cannot be identified directly with the segment.

(3) Common fixed costs should be clearly identified as unallocated in the contribution income statement by segments. Any attempt to allocate these types of costs, on some arbitrary basis, to the segments of the organization can destroy the value of responsibility accounting. It would lead to unfair evaluation of performance and misleading managerial decisions.

The following concepts are highlighted in the contribution approach:

1. Contribution margin: Sales minus variable costs

2. Segment margin: Contribution margin minus direct (traceable) fixed costs. Direct fixed costs include discretionary fixed costs such as certain advertising, R & D, sales promotion, and engineering and traceable and committed fixed costs such as depreciation, property taxes, insurance and the segment managers' salaries.

4. Net income: Segment margin less unallocated common fixed costs.

Segmental reporting can be made by:

- Division.
- Product or product line.
- Sales territory.
- Service center.
- Sales Person.
- Store or branch office.
- Domestic or foreign operations.

EXAMPLE 1

Figure 1 illustrates two levels of segmental reporting:

(1) By segments defined as divisions.
(2) By segments defined as product lines of a division.

FIGURE 1
SEGMENTAL INCOME STATEMENT

(1) Segments Defined as Divisions:

		SEGMENTS	
	Total Company	*Division 1*	*Division 2*
Sales	$150,000	$90,000	$60,000
Less: Variable costs:			
Manufacturing	40,000	30,000	10,000
Selling and admin.	20,000	14,000	6,000
Total variable costs	60,000	44,000	16,000
Contribution margin	$90,000	$46,000	$44,000
Less: Direct fixed costs	70,000	43,000	27,000
Divisional segment margin	$20,000	$3,000	$17,000
Less: Unallocated common fixed costs	$10,000		
Net income	$10,000		

(2) Segments Defined as Product Lines of Division 2

		SEGMENTS	
	Division 2	*Deluxe Model*	*Regular Model*
Sales	$60,000	$20,000	$40,000
Less: Variable costs			
Manufacturing	10,000	5,000	5,000
Selling and administrative	6,000	2,000	4,000
Total variable costs	16,000	7,000	9,000
Contribution margin	$44,000	$13,000	$31,000
Less: Direct fixed cost	26,500	9,500	17,000
Product line margin	$17,500	$3,500	$14,000
Less: Unallocated common fixed costs	$500		
Divisional segment margin	$17,000		

The segment margin is the best measure of the profitability of a segment. Unallocated fixed costs are common to the segments being evaluated and should be left unallocated in order not to distort the performance results of segments.

PROFIT VARIANCE ANALYSIS

Profit variance analysis, often called gross profit analysis, deals with how to analyze the profit variance which constitutes the departure between actual profit and the previous year's income or the budgeted figure. The primary goal of profit variance analysis is to improve performance and profitability in the future.

Profit, whether it is gross profit in absorption costing or contribution margin in direct costing, is affected by at least three basic items: sales price, sales volume, and costs. In addition, in a multi-product firm, if not all products are equally profitable, profit is affected by the mix of products sold.

The difference between budgeted and actual profits are due to one or more of the following:

(1) Changes in unit sales price and cost, called sales price and cost price variances, respectively. The difference between sales price variance and cost price variance is often called a contribution-margin-per-unit variance or a gross-profit-per-unit variance, depending upon what type of costing system being referred to, that is absorption costing or direct costing. Contribution margin is considered, however, a better measure of product profitability because it deducts from sales revenue only the variable costs that are controllable in terms of fixing responsibility. Gross profit does not reflect cost-volume-profit relationships. Nor does it consider directly traceable marketing costs.

(2) Changes in the volume of products sold summarized as the sales volume variance and the cost volume variance. The difference between the two is called the total volume variance.

(3) Changes in the volume of the more profitable or less profitable items referred to as the sales mix variance.

Detailed analysis is critical to management when multi-products exist. The volume variances may be used to measure a change in volume (while holding the mix constant) and the mix may be employed to evaluate the effect of a change in sales mix (while holding the quantity constant). This type of variance analysis is useful when the products are substituted for each other, or when products which are not necessarily substitutes for each are marketed through the same channel.

Types of Standards in Profit Variance Analysis

To determine the various causes for a favorable variance (an increase) or an unfavorable variance (a decrease) in profit we need some kind of yardsticks to compare against the actual results. The yardsticks may be based on the prices and costs of the previous year, or any year selected as the base periods. Some companies are summarizing profit variance analysis data in their annual report by showing departures from the previous year's reported income. However, one can establish a more effective control and budgetary method rather than the previous year's data. Standard or budgeted mix can be determined using such sophisticated techniques as linear and goal programming.

Single Product Firms

Profit variance analysis is simplest in a single product firm, for there is only one sales price, one set of costs (or cost price), and a unitary sales volume. An unfavorable profit variance can be broken down into four components: a sales price variance, a cost price variance, a sales volume variance, and a cost volume variance.

The sales price variance measures the impact on the firm's contribution margin (or gross profit) of changes in the unit selling price. It is computed as:

Sales price variance = (actual price - budget price) x actual sales

If the actual price is lower than the budgeted price, for example, this variance is unfavorable; it tends to reduce profit. The cost price variance, on the other hand, is simply the summary of price variances for materials, labor and overhead. (This is the sum of material price, labor rate, and factory overhead spending variances). It is computed as:

Cost price variance = (actual cost - budget cost) x actual sales

If the actual unit cost is lower than budgeted cost, for example, this variance is favorable; it tends to increase profit. We simplify the computation of price variances by taking the sales price variance less the cost price variance and call it the gross-profit-per-unit variance or contribution-margin-per-unit variance.

The sale volume variance indicates the impact on the firm's profit of changes in the unit sales volume. This is the amount by which sales would have varied from the budget if nothing but sales volume had changed. It is computed as:

Sales volume variance = (actual sales - budget sales) x budget price

If actual sales volume is greater than budgeted sales volume, this is favorable; it tends to increase profit. The cost volume variance has the same interpretation. It is:

(Actual sales - budget sales) x budget cost per unit.

The difference between the sales volume variance and the cost volume variance is called the total volume variance.

Multi – Product Firms

When a firm produces more than one product, there is a fourth component of the profit variance. This is the sales mix variance, the effect on profit of selling a different proportionate mix of products than that which has been budgeted. This variance arises when different products have different contribution margins. In a multi-product firm, actual sales volume can differ from that budgeted in two ways. The total number of units sold could differ from the target aggregate sales. In addition, the mix of the products actually sold may not be proportionate to the target mix. Each of these two different types of changes in volume is reflected in a separate variance.

The total volume variance is divided into the two: the sales mix variance and the sales quantity variance. These two variances should be used to evaluate the marketing department of the firm. The sales mix variance shows how well the department has done in terms of selling the more profitable products while the sales quantity variance measures how well the firm has done in terms of its overall sales volume. They are computed as:

Sales Mix Variance
(Actual Sales at budget mix - Actual Sales at actual mix) x Budget CM (or gross profit / unit)

Sales Quantity Variance
(Actual Sales at budget mix - Budget Sales at budget mix) x Budget CM (or gross profit / unit)

Sales Volume Variance
(Actual Sales at actual mix - Budget Sales at budget mix) x Budget CM (or gross profit / unit)

EXAMPLE 2

The Lake Tahoe Ski Store sells two ski models -- Model X and Model Y. For the years 20x1 and 20x2, the store realized a gross profit of $246,640 and only $211,650, respectively. The owner of the store was astounded since the total sales volume in dollars and in units was higher for 20x2 than for 20x1 yet the gross profit achieved actually declined. Given below are the store's unaudited operating results for 20x1 and 20x2. No fixed costs were included in the cost of goods sold per unit.

		Model X				*Model Y*		
YEAR	*Selling Price*	*Costs of Goods Sold per unit*	*Sales in Units*	*Sales Revenue*	*Selling Price*	*Costs of Goods Sold per unit*	*Sales in Units*	*Sales Revenue*
1	$150	$110	2,800	$420,000	$172	$121	2,640	$454,080
2	160	125	2,650	424,000	176	135	2,900	510,400

Explain why the gross profit declined by $34,990. Include a detailed variance analysis of price changes and changes in volume both for sales and cost. Also subdivide the total volume variance into change in price and changes in quantity.

Sales price and sales volume variances measure the impact on the firm's CM (or GM) of changes in the unit selling price and sales volume. In computing these variances, all costs are held constant in order to stress changes in price and volume. Cost price and cost volume variances are computed in the same manner, holding price and volume constant. All these variances for the take Tahoe Ski Store are computed below.

Sales Price Variance

Actual sales for 20x2:	$896,300
Model X 2,650 x $160 = $424,000	
Model Y 2,900 x $179 = $510,400	$934,400
Actual 20x2 sales at 20x1 prices:	
Model X 2,650 x $150 = $397,500	
Model Y 2,900 x $172 = $498,800	896,300
	$38,100 F

Sales Volume Variance

Actual 20x2 sales at 20x1 prices:	$896,300
Actual 20x1 sales (at 20x1 prices):	
Model X 2,800 x $150 = $420,000	
Model Y 2,640 x 172 = 454,080	874,080
	$22,220 F

Cost Price Variance

Actual cost of goods sold for 20x2:	$896,300
Model X 2,650 x $125 = $331,250	
Model Y 2,900 x $135 = $391,500	
Actual 20x2 sales at 20x1 costs:	
Model X 2,650 x $110 = $291,500	
Model Y 2,900 x $121 = $350,900	$642,400
	$80,350 U

Cost Volume Variance

Actual 20x2 sales at 20x1 costs:	$642,400
Actual 20x1 sales (at 20x1 costs):	

Model X 2,800 x $110 = $308,000		
Model Y 2,640 x 121 = 319,440		627,440
		$14,960 U

Total volume variance = sales volume variance - cost volume variance
= $22,220 F - $14,960 U = $7,260 F

The total volume variance is computed as the sum of a sales mix variance and a sales quantity variance as follows:

Sales Mix Variance

	*20x2 Actual Sale at 20x1 Mix**	*20x2 Actual Sale at 20x2 Mix*	*Diff.*	*20x1 Gross Profit per Unit*	*Variance ($)*
Model X	2,857	2,650	207 U	$40	$8,280 U
Model Y	2,693	2,900	207 F	51	10,557 F
	5,500	5,550			$2,277 F

*This is the 20x1 mix (used as standard or budget) proportions of 51.47% (or 2,800/5,440 = 51.47%) and 48.53% (or 2,640/5,440 = 48.53%) applied to the actual 20x2 sales figure of 5,550 units.

Sales Quantity Variance

	*20x2 Actual Sale at 20x1 Mix**	*20x2 Actual Sale at 20x1 Mix*	*Diff.*	*20x1 Gross Profit per Unit*	*Variance ($)*
Model X	2,857	2,800	57 F	$40	$2,280 F
Model Y	2,693	2,640	52 F	51	2,703 F
	5,550	5,440			$4,983 F

A favorable total volume variance is due to a favorable shift is the sales mix (that is from Model X to Model Y) and also to a favorable increase in sales volume (by 110 units) which is shown as follows.

Sale mix variance	$2,277 F
Sales quantity	4,983 F
	$7,260 F

However, there remains the decrease in gross profit. The decrease in gross profit of $34,990 can be explained as follows.

	Gains	*Losses*
Gain due to increased sales price	$38,100 F	80,350
Loss due to increased cost		
Gain due to increase in units sold	4,983 F	
Gain due to shift in sales mix	2,277 F	
	$45,360 F	$80,350

Hence, net decrease in gross profit = $80,350 - $45,360 = $34,990U

Hence, net decrease in gross profit = $80,350 - $45,360 = $34,990U

Despite the increase in sales price and volume and the favorable shift in sales mix, the Lake Tahoe Ski Store ended up losing $34,990 compare to 20x1. The major reason for this comparative loss was the tremendous increase in cost of goods sold, as costs for both Model X and Model Y went up quite significantly over 20x1. The store has to take a close look at the cost picture. Even though only variable and fixed costs should be analyzed in an effort to cut down on controllable costs. In doing that, it is essential that responsibility be clearly fixed to given individuals. In a retail business like the Lake Tahoe Ski Store, operating expenses such as advertising and payroll of store employees must also be closely scrutinized.

EXAMPLE 3

Shim and Siegel, Inc. sells two products, C and D. Product C has a budgeted unit CM (contribution Margin) of $3 and Product D has a budgeted Unit CM of $6. The budget for a recent month called for sales of 3,000 units of C and 9,000 units of D, for a total of 12,000 units. Actual sales totaled 12,200 units, 4,700 of C and 7,500 of D. Compute the sales volume variance and break this variance down into the (a) sales quantity variance and (b) sales mix variance.

Shim and Siegel's sales volume variance is computed below. As we can see, while total unit sales increased by 200 units, the shift in sales mix resulted in a $3,900 unfavorable sales volume variance.

Sale Volume Variance

	Actual Sales at Actual Mix	*Standard Sales at Budgeted Mix*	*Difference*	*Budgeted CM per Unit*	*Variance ($)*
Product C	4,700	3,000	1,700 F	$3	$5,100 F
Product D	7,500	9,000	1,500 U	6	9,000 U
	12,200	12,000			$3,900 U

In multiproduct firms, the sales volumes variance is further divided into a sales quantity variance and a sales mix variance. The computations of these variances are shown below.

Sales Quantity Variance

	Actual Sales at Budgeted Mix	*Standard Sales at Budgeted Mix*	*Difference*	*Standard CM per Unit*	*Variance ($)*
Product C	3,050	3,000	50 F	$3	$ 150 F
Product D	9,150	9,000	150 F	6	900 F
	12,200	12,000			$1,050 F

Sale Mix Variance

	Actual Sales at Budgeted Mix	*Standard Sales at Actual Mix*	*Difference*	*Standard CM per Unit*	*Variance ($)*
Product C	3,050	4,700	1,650 F	$3	$4,950 F
Product D	9,150	7,500	1,650 U	6	9,900 U
	12,200	12,200			$4,950 U

The sales quantity variance reflects the impact on the CM or GM (gross margin) of deviations from the standard sales volume, whereas the sales mix variance measures the impact on the CM of deviations from the budgeted mix. In the case of Shim and Siegel, Inc., the sales quantity variance came out to be favorable, i.e., $1,050 F and the sales mix variance came out to be unfavorable, i.e., $4,950 U. These variances indicate that while there was a favorable increase in sales volume by 200 units, it was obtained by an unfavorable shift in the sales mix, that is, a shift from Product D, with a high margin, to Product C, with a low margin.

Note that the sales volume variance of $3,900 U is the algebraic sum of the following two variances.

Sales quantity variance	$1,050 F
Sales mix variance	4,950 U
	$3,900 U

In conclusion, the product emphasis on high margin sales is often a key to success for multiproduct firms. Increasing sales volume is one side of the story; selling the more profitable products is another.

Managerial Planning and Decision Making

In view of the fact that Shim and Siegel, Inc. experienced an unfavorable sales volume variance of $3,900 due to an unfavorable (or less profitable) mix in the sales volume, the company is advised to put more emphasis on increasing the sales of Product D.

In doing that the company might wish to:

(a) Increase the advertising budget for succeeding periods to boost Product D sales;

(b) Set up a bonus plan in such a way that the commission is based on quantities sold rather than higher rates for higher margin items such as Product D or revise the bonus plan to consider the sale of product D;

(c) Offer a more lenient credit term for Product D to encourage its sale;

(d) Reduce the price of Product D enough to maintain the present profitable mix while increasing the sale of the product. This strategy must take into account the price elasticity of demand for Product D.

Sales Mix Analysis

Many product lines include a lower-margin price leader model, and often a high-margin deluxe model. For example, the automobile industry includes in its product line low-margin energy-efficient small cars and higher-margin deluxe models. In an attempt to increase over-all profitability, management would wish to emphasize the higher-margin expensive items, but salesmen might find it easier to sell lower- margin cheaper models. Thus, a salesman might meet his unit sales quota with each item at its budgeted price, but because of mix shifts he could be far short of contributing his share of budgeted profit.

Management should realize that

(1) Greater proportions of more profitable products mean higher profits.

(2) Higher proportions of lower margin sales reduce overall profit despite the increase in overall sales volume. That is to say that an unfavorable mix may easily offset a favorable increase in volume, and vice versa.

Performance Reports

Profit variance analysis aids in fixing responsibility by separating the causes of the change in profit into price, volume, and mix factors. With responsibility resting in different places, the segregation of the total profit variance is essential. The performance reports based on the analysis of profit variances must be prepared for each responsibility center, indicating the following:

1. Is it controllable?
2. Is it favorable or unfavorable?
3. If it is unfavorable, is it significant enough for further investigation?
4. Who is responsible for what portion of the total profit variance?
5. What are the causes for an unfavorable variance?
6. What is the remedial action to take?

The performance report must address these types of questions. The report is useful in two ways: (1) in focusing attention on situations in need of management action and (2) in increasing the precision of planning and control of sales and costs. The report should be produced as part of the overall standard costing and responsibility accounting system.

CHAPTER SUMMARY

The contribution approach attempts to measure the performance of segments of an organization. It classifies costs as being either direct (traceable) or common to the segments. Only those costs that are directly identified with the segments are allocated; costs that are not direct to the segments are treated as common costs and are not allocated.

Under the contribution approach we deduct variable costs from sales to arrive at a contribution margin. The direct fixed costs are then deducted from the contribution margin, yielding a segment margin. The segment margin is a measure of a segment success that is also useful for long-term planning and mix decision making.

This chapter has also been concerned with the analysis and evaluation of profit performances. If the responsibility is to be fixed for a profit center, comparisons of targets and attainments must be made, with the differences fully accounted for. Changes in income traceable to volume must be separated from changes due to prices. The effect of volume changes must be further divided to reveal the quantity factor and the mix factor.

CHAPTER 10
PERFORMANCE MEASUREMENT, BALANCED SCORECARD, AND TRANSFER PRICING

The ability to measure performance is essential in developing management incentives and controlling the operation toward the achievement of organizational goals. A typical decentralized subunit is an investment center which is responsible for an organization's invested capital (operating assets) and the related operating income. There are two widely used measurements of performance for the investment center: the rate of return on investment (ROI) and residual income (RI).

Goods and services are often exchanged between various divisions of a decentralized organization. The transfer price is the selling price credited to the selling division and the cost charged to the buying division for an internal transfer of a good or service. The choice of transfer prices not only affects divisional performance but is also important in decisions involving make or buy, whether to buy internally or outside, and choosing between production possibilities.

After studying the material in this chapter, you will be able to

- Compute return on investment (ROI) by means of the Du Pont formula and state how changes in sales, expenses, and assets affect the investment center's performance.
- Calculate the residual income (RI) and explain how it differs from ROI in measuring divisional performance.
- Explain how ROI and RI measures affect the division's investment decision.
- Outline the basic features of the Corporate Balanced Scorecard.
- Establish the right transfer price.
- Enumerate the strengths and weaknesses of various transfer prices between segments of an organization.

RATE OF RETURN ON INVESTMENT (ROI)

ROI relates net income to invest capital. Specifically,

ROI = Operating income

Operating assets

EXAMPLE 1

Consider the following financial data for a division:

Operating assets	\$100,000
Operating income	\$18,000

ROI = \$18,000/\$100,000 = 18%

The problem with this formula is that it only indicates how a division did and how well it fared in the company. Other than that, it has very little value from the standpoint of profit planning.

The Breakdown of ROI – Du Pont Formula

In the past, managers have tended to focus only on the margin earned and have ignored the turnover of assets. It is important to realize that excessive funds tied up in assets can be just as much of a drag on profitability as excessive expenses.

The Du Pont Corporation was the first major company to recognize the importance of looking at both margin and asset turnover in assessing the performance of an investment center. The ROI breakdown, known as the *Du Pont formula*, is expressed as a product of these two factors, as shown below.

$$\text{ROI} = \frac{\text{Operating income}}{\text{Operating assets}} = \frac{\text{Operating income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Operating assets}}$$

$$= \text{Margin} \times \text{Asset turnover}$$

The Du Pont formula combines the income statement and balance sheet into this otherwise static measure of performance. Margin is a measure of profitability or operating efficiency. It is the percentage of profit earned on sales. This percentage shows how many cents attach to each dollar of sales. On the other hand, asset turnover measures how well a division manages its assets. It is the number of times by which the investment in assets turns over each year to generate sales.

The breakdown of ROI is based on the thesis that the profitability of a firm is directly related to management's ability to manage assets efficiently and to control expenses effectively.

EXAMPLE 2

Assume the same data as in Example 1. Also assume sales of $200,000.

$$\text{Then, ROI} = \frac{\text{Operating income}}{\text{Operating assets}} = \frac{\$18{,}000}{\$100{,}000} = 18\%$$

Alternatively,

$$\text{Margin} = \frac{\text{Operating income}}{\text{Sales}} = \frac{\$18{,}000}{\$200{,}000} = 9\%$$

$$\text{Turnover} = \frac{\text{Sales}}{\text{Operating income}} = \frac{\$200{,}000}{\$100{,}000} = 2 \text{ times}$$

Therefore,

ROI = Margin x Turnover = 9% x 2 times

The breakdown provides a lot of insights to division managers on how to improve profitability of the investment center.

Specifically, it has several advantages over the original formula for profit planning. They are:

(1) Focusing on the breakdown of ROI provides the basis for integrating many of the management concerns that influence a division's overall performance. This will help managers gain an advantage in the competitive environment.

(2) The importance of turnover as a key to overall return on investment is emphasized in the breakdown. In fact, turnover is just as important as profit margin in enhancing overall return.

(3) The importance of sales is explicitly recognized, which is not there in the original formula.

(4) The breakdown stresses the possibility of trading one off for the other in an attempt to improve the overall performance of a company. The margin and turnover complement each other. In other words, a low turnover can be made up for by a high margin; and vice versa.

EXAMPLE 3

The breakdown of ROI into its two components shows that a number of combinations of margin and turnover can yield the same rate of return, as shown below:

Margin	*x*	*Turnover*	*= ROI*
(1) 9%	x	2 times	= 18%
(2) 6	x	3	= 18
(3) 3	x	6	= 18
(4) 2	x	9	= 18

The turnover-margin relationship and its resulting ROI are depicted in Figure 1.

ROI and Profit Planning

The breakdown of ROI into margin and turnover gives divisional managers insight into planning for profit improvement by revealing where weaknesses exist: margin or turnover, or both. Various actions can be taken to enhance ROI. Generally, they can:

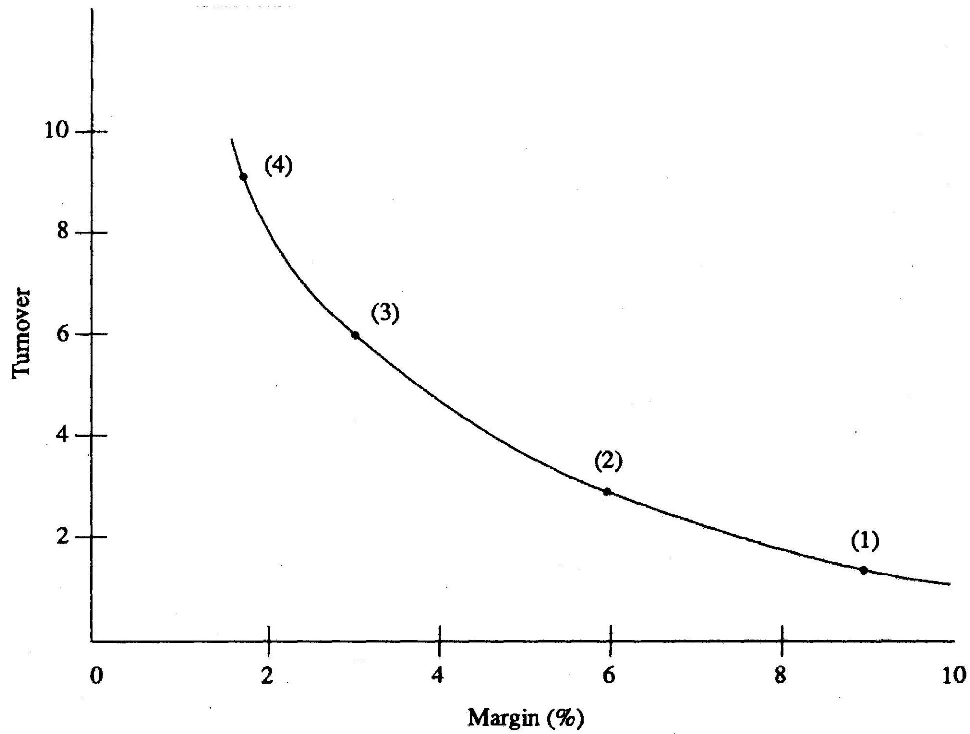
1. Improve margin
2. Improve turnover
3. Improve both

Alternative 1 demonstrates a popular way of improving performance. Margins may be increased by reducing expenses, raising selling prices, or increasing sales faster than expenses. Some of the ways to reduce expenses are:

(a) Use less costly inputs of materials.

(b) Automate processes as much as possible to increase labor productivity.

FIGURE 1
THE MARGIN-TURNOVER RELATIONSHIP



(c) Bring the discretionary fixed costs under scrutiny, with various programs either curtailed or eliminated. Discretionary fixed costs arises from annual budgeting decisions by management. Examples include advertising, research and development, and management development programs. The cost-benefit analysis is called for in order to justify the budgeted amount of each discretionary program.

A division with pricing power can raise selling prices and retain profitability without losing business. Pricing power is the ability to raise prices even in poor economic times when unit sales volume may be flat and capacity may not be fully utilized. It is also the ability to pass on cost increases to consumers without attracting domestic and import competition, political opposition, regulation, new entrants, or threats of product substitution. The division with pricing power must have a unique economic position. Divisions that offer unique, high-quality goods and services (where the service is more important than the cost) have this economic position.

Alternative 2 may be achieved by increasing sales while holding the investment in assets relatively constant, or by reducing assets. Some of the strategies to reduce assets are:

(a) Dispose of obsolete and redundant inventory. The computer has been extremely helpful in this regard, making perpetual inventory methods more feasible for inventory control.

(b) Devise various methods of speeding up the collection of receivables and also evaluate credit terms and policies.

(c) See if there are unused fixed assets.

(d) Use the converted assets obtained from the use of the previous methods to repay outstanding debts or repurchase outstanding issues of stock. The division may release them elsewhere to get more profit, which will improve margin as well as turnover.

Alternative 3 may be achieved by increasing sales or by any combinations of alternatives 1 and 2.

Figure 2 shows complete details of the relationship of ROI to the underlying ratios -margin and turnover--and their components. This will help identify more detailed strategies to improve margin, turnover, or both.

EXAMPLE 4

Assume that management sets a 20 percent ROI as a profit target. It is currently making an 18 percent return on its investment.

$$\text{ROI} = \frac{\text{Operating income}}{\text{Operating assets}} = \frac{\text{Operating income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Operating assets}}$$

Present situation:

$$18\% = \frac{18{,}000}{200{,}000} \times \frac{200{,}000}{100{,}000}$$

The following are illustrative of the strategies which might be used (each strategy is independent of the other).

Alternative 1: Increase the margin while holding turnover constant. Pursuing this strategy would involve leaving selling prices as they are and making every effort to increase efficiency so as to reduce expenses. By doing so, expenses might be reduced by $2,000 without affecting sales and investment to yield a 20% target ROI, as follows:

$$20\% = \frac{20{,}000}{200{,}000} \times \frac{200{,}000}{100{,}000}$$

Alternative 2: Increase turnover by reducing investment in assets while holding net profit and sales constant. Working capital might be reduced or some land might be sold, reducing investment in assets by $10,000 without affecting sales and net income to yield the 20% target ROI as follows:

$$20\% = \frac{18{,}000}{200{,}000} \times \frac{200{,}000}{90{,}000}$$

Alternative 3: Increase both margin and turnover by disposing of obsolete and redundant inventories or through an active advertising campaign. For example, trimming down $5,000 worth of investment in inventories would also reduce the inventory holding charge by $1,000. This strategy would increase ROI to 20%.

$$20\% = \frac{19{,}000}{200{,}000} \times \frac{200{,}000}{95{,}000}$$

Excessive investment in assets is just as much of a drag on profitability as excessive expenses. In this case, cutting unnecessary inventories also helps cut down expenses of carrying those inventories, so that both margin and turnover are improved at the same time. In practice, alternative 3 is much more common than alternative 1 or 2.

RESIDUAL INCOME (RI)

Another approach to measuring performance in an investment centers residual income (RI). RI is the operating income , which an investment center is able to earn above some minimum rate of return on its operating assets. RI, unlike ROI, is an absolute amount of income rather than a specific rate of return. When RI is used to evaluate divisional performance, the objective is to maximize the total amount of residual income, not to maximize the overall ROI figure.

RI = Operating income - (Minimum required rate of return x Operating assets)

EXAMPLE 5

In Example 1, assume the minimum required rate of return is 13 percent. Then the residual income of the division is

$18,000 - (13% x $100,000) = $18,000 - $13,000 = $5,000

RI is regarded as a better of measure of performance than ROI because it encourages investment in projects that would be rejected under ROI. A major disadvantage of RI, however, is that it cannot be used to compare divisions of different sizes. RI tends to favor the larger divisions due to the larger amount of dollars involved.

Residual Income and Economic Value Added

Residual income is better known as *economic value added* (EVA*)*. Many firms are addressing the issue of aligning division managers' incentives with those of the firm by using EVA as a measure of performance. EVA encourages managers to focus on increasing the value of the company to shareholders, because EVA is the value created by a company in excess of the cost of capital for the investment base. Improving EVA can be achieved in three ways:

(a) Invest capital in high-performing projects.
(b) Use less capital.
(c) Increase profit without using more capital.

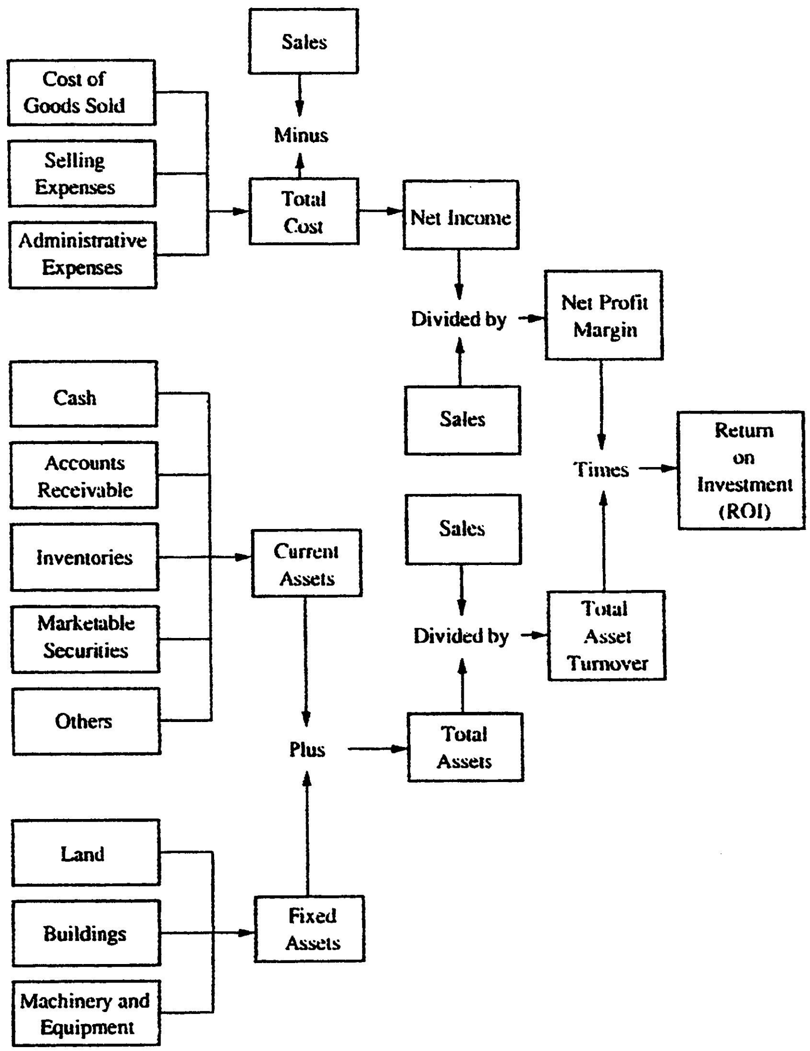
COST ACCOUNTING IN ACTION— Companies that Use EVA

Below is a list of well-known companies that use EVA:

Coca-Cola	Bausch & Lomb	Georgia-Pacific
Toys "R" Us	Briggs & Stratton	HermanMiller
Tupperware	JC Penney	Whirlpool
Eli Lilly	Sprint	

FIGURE 2

RELATIONSHIPS OF FACTORS INFLUENCING ROI



INVESTMENT DECISIONS UNDER ROI AND RI

The decision whether to use ROI or RI as a measure of divisional performance affect financial managers' investment decisions. Under the ROI method, division managers tend to accept only the investments whose returns exceed the division's ROI; otherwise, the division's overall ROI would decrease. Under the RI method, on the other hand, division managers would accept an investment as long as it earns a rate in excess of the minimum required rate of return. The addition of such an investment will increase the division's overall RI.

EXAMPLE 6

Consider the same data given in Examples 1 and 2:

Operating assets	$100,000
Operating income	$18,000
Minimum required rate of return	13%
ROI = 18% and RI = $5,000	

Assume that the division is presented with a project that would yield 15 percent on a $10,000 investment. The division manager would not accept this project under the ROI approach since the division is already earning 18 percent. Acquiring this project will bring down the present ROI to 17.73 percent, as shown below:

	Present	*New Project*	*Overall*
Operating assets (a)	$100,000	$10,000	$110,000
Operating income (b)	18,000	1,500*	19,500
ROI (b / a)	18%	15%	17.73%

*$10,00 x 15% = $1,500

Under the RI approach, the manager would accept the new project since it provides a higher rate than the minimum required rate of return (15 percent vs. 13 percent). Accepting the new project will increase the overall residual income to $5,200, as shown below:

	Present	*New Project*	*Overall*
Operating assets (a)	$100,000	$10,000	$110,000
Operating income (b)	18,000	1,500	19,500
Minimum required income at 13%(c)	13,000	1,300*	14,300
RI (b-c)	$5,000	$200	$5,200

*$10,000 x 13% = $1,300

BALANCED SCORECARD

A problem with just assessing performance with financial measures like profit, ROI and Economic Value Added (EVA) is that the financial measures are "backward looking.'" In other words, today's financial measures tell you about the accomplishments and failures of the past. An approach to performance measurement that also focuses on what managers are doing today to create future shareholder value is the Balanced Scorecard.

Essentially, a Balanced Scorecard is a set of performance measures constructed for four dimensions of performance. As indicated in Figure 3, the dimensions are financial, customer, internal processes, and learning and growth. Having financial measures is critical even if they are backward looking. After all, they have a great affect on the evaluation of the company by shareholders and creditors. Customer measures examine the company's success in meeting customer expectations. Internal process measures examine the company's success in improving critical business processes. And learning and growth measures examine the company's success in improving its ability to adapt, innovate, and grow. The customer, internal processes, and learning and growth measures are generally thought to be predictive of *future* success (i.e., they are not backward looking).

A variety of potential measures for each dimension of a Balanced Scorecard are indicated in Figure 3. After reviewing these measures, note how "balance" is achieved:

- Performance is assessed across a *balanced set of dimensions* (financial, customer, internal processes, and innovation).
- *Quantitative* measures (e.g., number of defects) are balanced with *qualitative* measures (e.g., ratings of customer satisfaction).
- There is a balance of *backward-looking* measures (e.g., financial measures like growth in sales) and *forward-looking* measures (e.g., number of new patents as an innovation measure).

Figure 4 presents examples of balanced scorecard measures by industry.

FIGURE 3
BALANCED SCORECARD

	Description	*Measures*
Financial	Is the company achieving its financial goals?	Operating income Return on assets Sales growth Cash flow from operations Reduction of administrative expense
Customer	Is the company meeting customer expectations?	Customer satisfaction Customer retention New customer acquisition Market share On-time delivery Time to fill orders
Internal Processes	Is the company improving critical internal processes?	Defect rate Lead time Number of suppliers Material turnover Percent of practical capacity
Learning and Growth	Is the company improving its ability to innovate?	Amount spent on employee training Employee satisfaction Employee retention Number of new products New product sales as a percent of total sales Number of patents

FIGURE 4

EXAMPLES OF BALANCED SCORECARD MEASURES BY INDUSTRY

Industry	*Financial Dimension*	*Customer Dimension*	*Internal Business Process Dimension*	*Learning and Growth Dimension*
Airlines	Return on assets	Frequent flier program participation rates	Percentage of on-time takeoffs and arrivals	Labor contract length
Consumer	Ratio of assets	Number of new	Number of new	Hours of

retail banks	to debt	accounts opened	branches	employee training completed
Accounting, consulting, and law firms	Profit margin	Client retention rate	Percentage of projects completed on time	Certification and education levels of professionals
Computer manufacturers	Sales growth from new products	Number of corporate customers	Number of product defects	Percentage of factory employees who completed quality control training
Supermarkets	Inventory turnover	Customer satisfaction	Product spoilage rates	Employee turnover rates

There are numerous Web resources that you can log on to learn more about the balanced score card and performance evaluations. For example, managers frequently look to industry "best practices" or examples of successful implementations at other firms when developing measurement programs. The following list below provides valuable resources for evaluating performance and business decision making across a wide range of industries.

- **The Balanced Scorecard Institute (www.balancedscorecard.org).** The Balanced Scorecard Institute is an independent educational institute that provides training and guidance to assist government agencies and companies in applying best practices in balanced scorecard (BSC) and performance measurement for strategic management and transformation. Their website provides background information about implementing the balanced scorecard and the proper selection of nonfinancial measures. It also provides several examples of past successes.

- **American Productivity and Quality Center (www.apqc.org).** The American Productivity & Quality Center (APQC), an internationally recognized non profit organization, provides expertise in benchmarking and best practices research. APQC helps organizations adapt to rapidly changing environments, build new and better ways to work, and succeed in a competitive marketplace. It has a membership of over 450 prestigious global firms including 3M, AT&T, Cisco Systems, and Ernst & Young. The objective of this collaborative center is to "Understand how innovative organizations create succession management programs to identify and cultivate potential leaders who will provide a sustainable business advantage." The Best Practices and Free Resources links lead to many useful resources.

- **Management Help (www.managementhelp.org).** This website offers a robust "library" of decision-making tools and library resources. The site offers many resources on such topics as strategic planning, performance measurement, employee development, and make-or-outsource decisions. It also includes online discussion groups, decision-making guidance, and free reference material.

- **Performance Measurement Association (www.performanceportal.org).** This website, a home to the United Kingdom's Performance Measurement Association, covers references to valuable articles, a free newsletter, and insight into current trends in performance measurement. It is representative of the types of professional associations that managers join to share ideas and continue the development of their personal and managerial skills.

TRANSFER PRICING

Goods and services are often exchanged between various divisions of a decentralized organization. A major goal of transfer pricing is to enable divisions that exchange goods or services to act as independent businesses.

The question then is: What monetary values should be assigned to these exchanges or transfers? Market price? Some kind of cost? Some version of either? Unfortunately, there is no single transfer price that will please everybody - that is, top management, the selling division, and the buying division-involved in the transfer. Various transfer pricing schemes are available, such as market price, cost-based price, or negotiated price.

The choice of a transfer pricing policy (i.e., which type of transfer price to use) is normally decided by top management. The decision will typically include consideration of the following:

- *Goal congruence*. Will the transfer price promote the goals of the company as a whole? Will it harmonize the divisional goals with organizational goals?

- *Performance evaluation*. Will the selling division receive enough credit for its transfer of goods and services to the buying division? Will the transfer price hurt the performance of the selling division?

- *Autonomy*. Will the transfer price preserve autonomy; the freedom of the selling and buying division managers to operate their divisions as decentralized entities?

- Other factors such as minimization of tariffs and income taxes and observance of legal restrictions.

Transfer prices can be based on:

- Market price
- Cost-based price - variable or full cost
- Negotiated price
- General formula, which is usually the sum of variable costs per unit and opportunity cost for the company as a whole (lost revenue per unit on outside sales)

Market Price

Market price is the best transfer price in the sense that it will maximize the profits of the company as a whole, if it meets the following two conditions:

- There exists a competitive market price.
- Divisions are independent of each other.

If either one of these conditions is violated, market price will not lead to an optimal economic decision for the company.

Cost-Based Price - Variable or Full Cost

Cost-based transfer price, another alternative transfer pricing scheme, is easy to understand and convenient to use. But there are some disadvantages, including:

- Inefficiencies of selling divisions are passed on to the buying divisions with little incentive to control costs. The use of standard costs is recommended in such a case.

- The cost-based method treats the divisions as cost centers rather than profit or investment centers. Therefore, measures such as ROI and RI cannot be used for evaluation purposes.

The variable-cost-based transfer price has an advantage over the full cost method because in the short run it may tend to ensure the best utilization of the overall company's resources. The reason is that, in the short run, fixed costs do not change. Any use of facilities, without incidence of additional fixed costs, will increase the company's overall profits.

Negotiated Price

A negotiated price is generally used when there is no clear outside market. A negotiated price is a price agreed upon between the buying and selling divisions that reflects unusual or mitigating circumstances. This method is widely used when no intermediate market price exists for the product transferred and the selling division is assured of a normal profit.

EXAMPLE 7

ABC Corporation just purchased a small company that specializes in the manufacture of part No. 510. ABC is a decentralized organization, and will treat the newly acquired company as an autonomous division called *Division B* with full profit responsibility. Division B's fixed costs total $30,000 per month, and variable costs per unit are $18. Division B has operating capacity of 5,000 units, which is sufficient to sell as many as 2,500 units to other divisions. The normal selling price per unit is $30.

Division A of ABC Corporation is currently purchasing 2,500 units of part no. 510 per month from an outside supplier at $29 per unit, which represents the normal selling market price $30 less a quantity discount. Top management is hoping that Division A will consider buying part No. 510 from Division B.

Top management of the company wishes to decide what transfer price should be used.

Top management may consider the following alternative prices:

(a) $30 market price

(b) $29, the price that Division A is currently paying to the outside supplier

(c) $23.50 negotiated price, which is $18 variable cost plus 1/2 of the benefits of an internal transfer [($29-$18) x 1/2]

(d) $24 full cost, which is $18 variable cost plus $6 ($30,000/5,000 units) fixed cost per unit

(e) $18 variable cost

We will discuss each of these prices:

(a) $30 would not be an appropriate transfer price. Division B cannot charge a price more than the price Division A is paying now ($29).

(b) $29 would be an appropriate transfer price if top management wishes to treat the divisions as autonomous investment centers. This price would cause all of the benefits of internal transfers to accrue to the selling division, with the buying division's position remaining unchanged.

(c) \$23.50 would be an appropriate transfer price if top management wishes to treat the divisions as investment centers, but wishes to share the benefits of an internal transfer equally between them, as follows.

Variable costs of Division B	\$18.00
1/2 of the difference between the variable costs of Division B and the price Division A is paying (\$29 - \$18) x 1/2	5.50
Transfer price	\$23.50

Note: \$23.50 is just one example of a negotiated transfer price. The exact price depends on how the benefits are divided.

(d) \$24 [\$24 = \$18 + (\$30,000 / 5,000 units)] would be an appropriate transfer price if top management treats divisions like cost centers with no profit responsibility. All benefits from both divisions will accrue to the buying division. This will maximize the profits of the company as a whole, but affect adversely the performance of the selling division. Another disadvantage of this cost-based approach is that inefficiencies (if any) of the selling division are being passed on to the buying division.

(e) \$18 would be an appropriate transfer price for guiding top management in deciding whether transfers between the two divisions should take place. Since \$18 is less than the outside purchase price of the buying division, and the selling division has excess capacity, the transfer should take place, because it will maximize the profits of the company as a whole. However, if \$18 is used as a transfer price, then all of the benefits of the internal transfer accrue to the buying division and it will hurt the performance of the selling division.

General Formula

It is not easy to find a cure-all answer to the transfer pricing problem, since the three problems of goal congruence, performance evaluation, and autonomy must all be considered simultaneously. It is generally agreed, however, that some form of competitive market price is the best approach to the transfer pricing problem. The following formula would be helpful in this effort:

Transfer price =	Variable costs per unit + Opportunity costs per unit for the company as a whole

Opportunity costs are defined here as net revenue foregone by the company as a whole if the goods and services are transferred internally. The reasoning behind this formula is that the selling division should be allowed to recover its variable costs plus opportunity cost (i.e., revenue that it could have made by selling to an outsider) of the transfer. The selling department should not have to suffer lost income by selling within the company.

CHAPTER SUMMARY

Return on investment (ROI) and residual income (RI) are two most widely used measures of divisional performance. Emphasis was placed on the breakdown of the ROI formula, commonly referred to as the *Du Pont formula*. The breakdown formula has several advantages over the original formula in terms of profit planning. The choice of evaluation systems--ROI or RI--will greatly affect a division's investment decisions.

Transfer pricing relates to the price to be charged in an exchange of goods and services between two investment centers within an organization. Unfortunately, there is no single transfer price that is satisfactory to the parties involved in the transfer--the selling division, buying division, and top management.

In practical terms, the best transfer price to use is negotiated market price. However, when that is not available, say for example there is a new product, budgeted cost plus profit markup should be used. In any event, the buying division should never be charged a transfer price that exceeds the outside market price. Whether the buying division is allowed to buy outside or stay inside depends on what is best for corporate profitability.

CHAPTER 11
NONROUTINE DECISIONS AND
LIFE-CYCLE AND TARGET COSTING

When performing the manufacturing and selling functions, management is constantly faced with the problem of choosing between alternative courses of action. Typical questions to be answered include: What to make? How to make it? Where to sell the product? and What price should be charged? In the short run, management is faced with many short-term, nonroutine decisions. In a short-term situation, fixed costs are generally irrelevant to the decision at hand. Managerial accountants must recognize as a major decision tool, the two important concepts: *relevant costs* and *contribution margin*.

After studying the material in this chapter, you will be able to

- Identify the costs that are relevant for a particular decision.
- Decide if an order should be accepted at below the normal selling price.
- Determine the bid price on a contract.
- Describe an outsourcing decision.
- Determine whether to drop or keep a product line or service.
- Decide whether further processing of a product is justified.
- State why the contribution margin per unit of limited resource is the deciding factor in product mix decisions with *limited* resources (such as warehouse or display space) and the *theory of constraints.*
- State why a *life-cycle costing* approach is appropriate for project costing.
- Explain the *target costing* process for a new product.

RELEVANT COSTS DEFINED

In each of the above situations, the ultimate management decision rests on cost data analysis. Cost data are important in many decisions, since they are the basis for profit calculations. Cost data are classified by function, behavior patterns, and other criteria, as discussed previously.

However, not all costs are of equal importance in decision making, and managers must identify the costs that are relevant to a decision. Such costs are called relevant costs. The relevant costs are the expected future costs (and also revenues) which differ between the decision alternatives. Therefore, the sunk costs (past and historical costs) are not considered relevant in the decision at hand. What is relevant are the incremental or differential costs.

Under the concept of *relevant costs*, which may be appropriately titled the incremental, differential, or relevant cost approach, the decision involves the following steps:

1. Gather all costs associated with each alternative.
2. Drop the sunk costs.
3. Drop those costs which do not differ between alternatives.
4. Select the best alternative based on the remaining cost data.

EXAMPLE 1

To illustrate the irrelevance of sunk costs and the relevance of incremental costs, let us consider a replacement decision problem. A company owns a milling machine that was purchased three years ago for $25,000. Its present book value is $17,500. The company is contemplating replacing this machine with a new one which will cost $50,000 and have a five-year useful life. The new machine will generate the same amount of revenue as the old one but will substantially cut down on variable operating costs. Annual sales and operating costs of the present machine and the proposed replacement are based on normal sales volume of 20,000 units and are estimated as follows:

	Present Machine	*New Machine*
Sales	$60,000	$60,000
Variable Costs	35,000	20,000
Fixed Costs:		
Depreciation (straight-line)	2,500	10,000
Insurance, Taxes, etc.	4,000	4,000
Net Income	$18,500	$ 26,000

At first glance, it appears that the new machine provides an increase in net income of $7,500 per year. The book value of the present machine, however, is a sunk cost and is irrelevant in this decision. Furthermore, sales and fixed costs such as insurance, taxes, etc., also are irrelevant since they do not differ between the two alternatives being considered. Eliminating all the irrelevant costs leaves us with only the incremental costs, as follows.

Savings in variable costs	$15,000
Less: Increase in Fixed Costs	10,000 *
Net Annual Cash Saving Arising	

from the New Machine	$5,000

*exclusive of $2,500 sunk cost

Pricing a Special Order

A company often receives a short-term, special order for its products at lower prices than usual. In normal times, the company may refuse such an order since it will not yield a satisfactory profit. If the company has *idle* (excess) capacity or times are bad, however, such an order should be accepted if the incremental revenue obtained from it exceeds the incremental costs. The company is better off to receive some revenue, above its incremental costs, than to receive nothing at all. *Note:* The firm must make sure, however, that the products or services involved are sufficiently different from its regular counterparts to avoid violating federal price discrimination laws.

Such a price, one lower than the regular price, is called a *contribution price.* This approach to pricing is often called the contribution approach to pricing or the variable pricing model.

This approach is most appropriate under the following conditions:
(1) When there is idle capacity,
(2) When operating in a distress situation, and
(3) When faced with sharp competition or in a competitive bidding situation.

EXAMPLE 2

Assume that a company with 100,000-unit capacity is currently producing and selling only 90,000 units of product each year at a regular price of $2, indicating that the company has idle capacity. If the variable cost per unit is $1 and the annual fixed cost is $45,000, the income statement looks as follows:

Sales (90,000 units)	$180,000	$2.00
Less: Variable Cost (90,000 units)	90,000	1.00
Contribution Margin	$90,000	$1.00
Less: Fixed Cost	45,000	0.50
Net Income	$45,000	$0.50

The company has just received an order that calls for 10,000 units @$1.20, for a total of $12,000. The acceptance of this order will not affect regular sales. The company's president is reluctant to accept the order, however, because the $1.20 price is below the $1.50 factory unit cost ($1.50 = $1.00 + $0.50). Should the company accept the order?

The answer is yes. The company can add to total profits by accepting this special order even though the price offered is below the unit factory cost. At a price of $1.20, the order will contribute \$0.20 per unit (CM per unit = \$1.20 - \$1.00 = \$0.20) toward fixed cost, and profit will increase by \$2,000 (10,000 units x \$0.20).

Using the contribution approach to pricing, the variable cost of \$1 will be a better guide than the full unit cost of \$1.50. Note that the fixed costs do not change because of the presence of idle capacity.

The same result can be seen as follows:

	Per Unit	*Without Special Order (90,000 units)*	*Without Special Order (100,000 units)*	*Difference*
Sales	\$2.00	\$180,000	\$192,000	\$12,000
Less: Variable Costs	1.00	90,000	100,000	10,000
CM	1.00	\$ 90,000	\$ 92,000	\$ 2,000
Less: Fixed Cost	0.50	45,000	45,000	0
Net Income	\$0.50	\$ 45,000	\$ 47,000	\$ 2,000

EXAMPLE 3

The marketing manager had decided that for Product A he wants a markup of 30% over cost. Particulars concerning a unit of Product A are given as follows:

Direct material	\$4,000
Direct labor	10,000
Overhead	2,500
Total Cost	\$16,500
Markup on cost (30%)	4,950
Selling price	\$21,450

Total direct labor for the year equals \$1,200,000. Total overhead for the year equals 25% of direct labor (\$300,000), of which 40% is fixed and 60% is variable. The customer offers to buy a unit of Product A for \$18,000. Idle capacity exists.

You should accept the extra order because it provides an increased contribution margin, as indicated below:

Selling price		\$18,000
Less: variable costs		
Direct material	\$4,000	
Direct labor	10,000	
Variable overhead (\$10,000 x 15%)*	1,500	(15,500)
Contribution margin		\$2,500

Less: fixed overhead	(0)
Net Income	$2,500

* Variable overhead equals 15% of direct labor, calculated as follows

$$\frac{\text{Variable overhead}}{\text{Direct Labor}} = \frac{60\% \text{ X } \$300{,}000}{\$1{,}200{,}000} = \frac{\$180{,}000}{\$1{,}200{,}000} = 15\%$$

Bid Price

The relevant cost approach can be used to determine the bid price on a contract.

EXAMPLE 4

Travis Company has received an order for 6,000 units. The management accountant wants to know the minimum bid price that would produce a $14,000 increase in profit. The current income statement follows:

Income Statement

Sales (30,000 units x $20)		$600,000
Less: cost of sales		
Direct material	$60,000	
Direct labor	150,000	
Variable overhead (150,000* 40%)	60,000	
Final overhead	80,000	(350,000)
Gross margin		$250,000
Less: selling and administrative expenses		
Variable (includes transportation costs of $0. 20 per unit)	15,000	
Fixed	85,000	(100,000)
Net income		$150,000

If the contract is taken, the cost patterns for the extra order will remain the same, with these exceptions:

- Transportation costs will be paid by the customer.
- Special tools costing $6,000 will be required for just this order and will not be reusable.
- Direct labor time for each unit under the order will be 10% longer.

The bid price is derived in this manner:

Current Cost Per Unit

Selling price	$20	($600,000/30,000)
Direct material	2	($60,000/30,000)
Direct labor	5	($150,000/30,000)
Variable overhead	40% of direct labor cost	($60,000/$150,000)
Variable selling and administrative expense	$0.50	($15,000/30,000)

As can be seen in the income statement on the next page, the contract price for the 6,000 units should be $80,000 ($680,000-$600,000), or $13.33 per unit($80,000/6,000).

The contract price per unit of $13.33 is less than the $20 current selling price per unit. Note, by accepting the order, total fixed cost will remain the same except for the $6,000 cost of special tools.

Income Statement

	30,000 Current	*36,000 Projected*
Sales	$ 600,000	$680,000 (d) Computed last
Cost of sales		
Direct material	$60,000	$72,000 ($2 x 36,000)
Direct labor	150,000	183,000 ($150,000 + [6,000 x $5.50 (a)])
Variable overhead	$60,000	$73,200 ($183,000 x 40%)
Fixed overhead	80,000	86,000 ($80,000 + $6,000)
Total	$350,000	$414,200
Variable selling and administration costs	$15,000	$16,800 ($15,000 + [6,000 x $0.30]) (b)
Fixed selling and administrative costs	85,000	85,000
Total	$100,000	$101,800
Net Income	$150,000	$164,000 (d)

(a) $5 * 1.10 = $5.50
(b) $0.50 - $0.20 = $0.30
(c) $150,000 + $14,000 = $164,000
(d) Net income + selling and administrative expensive + cost of sales = sales
$164,000 + $101,800 + $414,200 = $680,000

Outsourcing: The Make–or–Outsource Decision

Often companies purchase subcomponents used to make their products instead of making them in their in-house manufacturing facilities. Buying services, products, or components of products from outside vendors instead of producing them is called *outsourcing.* The decision whether to produce a subcomponent in-house or to buy it externally from an outside vendor is called a "make-or-buy (outsource)" decision. Examples include:

(1) Payroll processing in-house or outsource it to an outside service bureau
(2) Developing a training program in-house or sending employees outside for training
(3) Providing data processing and network services internally or buying them (Benefits: access to technology and cost savings)

Other strong candidates for outsourcing include: managing fleets of vehicles, sales and marketing, E-commerce, information technology, human resource, and custodial services. In recent years, companies have been outsourcing more and more business processes including payroll, employee benefits, customer support, invoicing, and IT management. Companies claim that outsourcing leads to substantial cost savings, allows them to focus on their core competencies, and ultimately increases shareholder value.

This decision involves both quantitative and qualitative factors. The qualitative factors include ensuring product quality and the necessity for long-run business relationships with the supplier. The quantitative factors deal with cost. The quantitative effects of the make-or-buy decision are best seen through the relevant cost approach.

Outsourcing is often used interchangeably with *offshoring* and sometimes with *business process outsourcing (BPO)*. It requires more precise definition. When a company outsources the supply of products, services or their component parts, it delegates them to a third party provider - whether abroad or at home. BPO, ore specialized form of outsourcing in which an entire business process, such as accounting, procurement or human resources, is handed to a third party. With offshoring, a company relocates processes or production to a lower-cost, foreign location in the form of subsidiaries or affiliates.

EXAMPLE 5

Assume that a firm has prepared the following cost estimates for the manufacture of a subassembly component based on an annual production of 8,000 units:

	Per Unit	*Total*
Direct Materials	$5	$40,000
Direct Labor	$4	$32,000
Variable Factory Overhead Applied	4	32,000
Fixed Factory Overhead Applied (150% of direct labor cost)	6	48,000
Total Cost	$19	152,000

The supplier has offered to provide the subassembly at a price of $16 each. Two-thirds of fixed factory overhead, which represents executive salaries, rent, depreciation, and taxes, continue regardless of the decision. Should the company buy or make the product?

The key to the decision lies in the investigation of those relevant costs that change between the make-or-buy alternatives. Assuming that the productive capacity will be idle if not used to produce the subassembly, the analysis takes the following form:

	Per Unit		*Total of 8,000 Unit*	
	Make	*Buy*	*Make*	*Buy*
Purchase Price		$16		$128,000
Direct Materials	$ 5		$40,000	
Direct Labor	4		32,000	
Variable overhead	4		32,000	
Fixed Overhead that can be avoided by Not Making	2		16,000	
Total Relevant Costs	$ 15	$16	$120,000	$128,000
Difference in Favor of Making		$1		$8,000

The make-or-buy decision must be investigated, along with the broader perspective of considering how best to utilize available facilities. The alternatives are:

1. Leaving facilities idle.
2. Buying the parts and renting out idle facilities.
3. Buying the parts and using idle facilities for other products.

COST ACCOUNTING IN ACTION— BP Outsources HR

The outsourcing trend is global. Consider BP (British Petroleum), the largest company in the UK. In 2000, the company signed a 600 million dollar, five-year deal to outsource the administration of human resources (HR). Interestingly, it signed the deal with Exult, a relatively small start-up in California. Using Internet-based technology and administrative centers, Exult deals with everything from pay and benefits to training, recruitment, and relocation.

The transition to Exult has not been trouble free. In Germany, for example, BP's third largest location with more than 10,000 employees, privacy laws make it difficult to process personnel information. In fact, BP workers outside Germany can't use technology to apply for jobs at BP's German locations. Also, BP held on to 1,500 HR employees as a "safety net" for the outsourcing experiment. This limited near-term cost savings. Still, BP expects the system to work well and even bought a 9 percent stake in Exult.

Note: Reliable out sourcing requires the following:

1. Begin by outsourcing simple activities such as data processing. Step up gradually to complex processes such as financial services.

2. Check among providers for any accreditation with internal standard setters.
3. Draw up detailed terms and conditions for the contract, including how services should be delivered and providers' incentives for meeting targets.

The Sell-or-Process-Further Decision

When two or more products are produced simultaneously from the same input by a joint process, these products are called joint products. The term joint costs is used to describe all the manufacturing costs incurred prior to the point where the joint products are identified as individual products, referred to as the split-off point. At the split-off point some of the joint products are in final form and saleable to the consumer, whereas others require additional processing.

In many cases, however, the company might have an option: it can sell the goods at the split-off point or process them further in the hope of obtaining additional revenue. In connection with this type of decision, called the "sell-or-process-further" decision, joint costs are considered irrelevant, since the joint costs have already been incurred at the time of the decision, and therefore represent sunk costs. The decision will rely exclusively on additional revenue compared to the additional costs incurred due to further processing.

EXAMPLE 6

The Bailey Company produces three products, A, B, and C from a joint process. Joint production costs for the year were $120,000. Product A may be sold at the split-off point or processed further. The additional processing requires no special facilities and all additional processing costs are variable. Sales values and cost needed to evaluate the company's production policy regarding product A follow:

		Additional Cost & Sales Values after Further Processing	
Units Produced	*Sales Value at Split-Off*	*Sales*	*Costs*
3,000	$60,000	$90,000	$25,000

Should product A be sold at the split-off point or processed further?

Incremental sales revenue	$30,000
Incremental costs (variable), additional processing	25,000
Incremental gain (CM)	$5,000

In summary, product A should be processed as shown above. Keep in mind that the joint production cost of $120,000 is not included in the analysis, since it is a sunk cost and, therefore, irrelevant to the decision.

Keeping or Dropping A Product Line

Another type of nonrecurring decisions managers must face is whether to keep or drop unprofitable segments, such as product lines, services, sales territories, divisions, or departments. The goal of this decision analysis, known as *segment profitability analysis*, is to identify the segments that have a negative segment margin. A *segment margin* is a segment's sales revenue minus its direct costs (variables costs and direct fixed costs identified with the segment.

The decision whether to drop an old product line or add a new one must take into account both qualitative and quantitative factors. However, any final decision should be based primarily on the impact the decision will have on the company's overall contribution margin or net income.

EXAMPLE 7

Alpha-Omega Grocery Store has three major product lines: produce, meats, and canned food. The store is considering the decision to drop the meat line because the income statement shows it is being sold at a loss. Note the income statement for these product lines below:

	Produce	*Meats*	*Canned Food*	*Total*
Sales	$10,000	$15,000	$25,000	$50,000
Less: Variable Costs	6,000	8,000	12,000	26,000
CM	$4,000	7,000	13,000	$24,000
Less: Fixed costs				
Direct	$2,000	$6,500	$4,000	$12,500
Allocated	1,000	1,500	2,500	5,000
Total	$3,000	$8,000	$6,500	$17,500
Net Income	$1,000	$(1,000)	$6,500	$6,500

In this example, direct fixed costs are those costs that are identified directly with each of the product lines, whereas allocated fixed costs are the amount of common fixed costs allocated to the product lines using some base such as space occupied. The amount of common fixed costs typically continues regardless of the decision and thus cannot be saved by dropping the product line to which it is distributed.

The comparative approach showing the effects on the company as a whole with and without the meat line is shown below:

	Keep Meats	*Drop Meats*	*Difference*
Sales	$50,000	$35,000	$(15,000)
Less: Variable cost	26,000	18,000	(8,000)

CM	$24,000	$17,000	$(7,000)
Less: Fixed cost			
Direct	$12,500	$6,000	$(6,500)
Allocated	5,000	5,000	0
Total	$17,500	$11,000	$(6,500)
Net Income	$6,500	$6,000	$(500)

Alternatively, the incremental approach would show the following:

If Meats Dropped	
CM lost	$7,000
Gains: Direct fixed costs avoided	6,500
Increase (decrease) in net income	$(500)

From either of the two methods, we see that by dropping meats the store will lose an additional $500. Therefore, the meat product line should be kept. One of the great dangers in allocating common fixed costs is that such allocations can make a product line look less profitable than it really is. Because of such an allocation, the meat line showed a loss of $1,000, but it in effect contributes $500 ($7,000 - $6,500) to the recovery of the store's common fixed costs.

Product Mix Decisions in the Presence of Limited Resources

In general, the emphasis on products with higher contribution margin maximizes a firm's total net income, even though total sales may decrease. This is not true, however, where there are constraining factors and scarce resources. The constraining factor may be machine hours, labor hours, or cubic feet of warehouse space.

In the presence of these constraining factors, maximizing total profits depends on getting the highest contribution margin per unit of the factor (rather than the highest contribution margin per unit of product output).

EXAMPLE 8

Assume that a company produces two products, A and B, with the following contribution margins per unit.

	A	*B*
Sales	$8	$24
Variable costs	6	20
CM	$2	$4

Annual fixed costs $42,000

As is indicated by CM per unit, B is more profitable than A since it contributes more to the company's total profits than A ($4 vs. $2). But let us assume that the firm has a limited capacity of 10,000 labor hours. Further, assume that A requires two labor hours to produce and B requires five labor hours. One way to express this limited capacity is to determine the contribution margin per labor hour.

	A	B
CM/ units	$2.00	$4.00
Labor hours required per unit	2 hrs.	5 hrs.
CM per labor hour	$1.00	$0.80

Since A returns the higher CM per labor hour, it should be produced and B should be dropped. Another way to look at the problem is to calculate total CM for each product.

	A	B
Maximum possible production	5,000 units*	2,000 units**
CM per unit	$2	$4
Total CM	$10,000	$8,000

* (10,000 hours / 2 hours)
**(10,000 hours / 5 hours)

Again, product A should be produced since it contributes more than B ($10,000 vs. $8,000).

Note: The presence of only one limited resource is unrealistic. Virtually all firms encounter multiple constraints: restrictions on materials, labor inputs, demand for each product, warehouse space, display space, and so on. The solution of the product mix problem with multiple constraints is considerably more complex and requires a technique known as *linear programming*.

Theory of Constraints

A binding constraint can limit a company's profitability. For example, a manufacturing company may have a *bottleneck operation*, through which every unit of a product must pass before moving on to other operations. The *theory of constraints (TOC)* calls for identifying such limiting constraints and seeking ways to relax them. Also referred to as *managing constraints*, this management approach can significantly improve an organization's level of goal attainment. Among the ways that management can relax a constraint by expanding the capacity of a bottleneck operation are the following:

- *Outsourcing* (subcontracting) all or part of the bottle neck operation.
- Investing in additional production equipment and employing *parallel processing*, in which multiple product units undergo the same production operation simultaneously.
- Working *overtime* at the bottleneck operation.
- *Retaining* employees and shifting them to the bottleneck.

- Eliminating any *non-value-added activities* at the bottleneck operation.

YOU SHOULD REMEMBER

Identification of the relevant costs and benefits is an important step in making any economic decision. Nonetheless, one often overlooks relevant costs or incorrectly includes irrelevant data. Keep in mind four common mistakes to avoid in decision making.

1. **Sunk costs.** The book value of an asset, defined as its acquisition cost less the accumulated depreciation, is a sunk cost. Sunk costs cannot be changed by any current or future course of action, so they are *irrelevant* in decision making. Nevertheless, a common behavioral tendency is to give undue importance to book values in decisions that involve replacing an asset or disposing of obsolete inventory. Managers often seek to justify their past decisions by refusing to dispose of an asset, if a better alternative has been identified. *Ignore sunk costs.*

2. **Unitized fixed costs.** For product-costing purposes, fixed costs are *unitized* (divided by some activity measure) and assigned to individual units of product. The result is to make fixed cost appear *variable*. While there are legitimate reasons for this practice, from *product-costing* perspective, it can create confusion in *decision making.* Therefore, in a decision analysis it is usually wise to include a fixed cost in its total amount, rather than as a per-unit cost. *Beware of unitized fixed costs in decision making.*

3. **Allocated fixed costs.** It is also common to allocate fixed costs across divisions, departments, or product lines. A possible result is that a product or department may appear unprofitable when in reality it does make a contribution toward covering fixed costs and profit. Before deciding to eliminate a department, be sure to ask which costs will be *avoided* if a particular alternative is selected. *Beware of allocated fixed costs; identify the avoidable costs.*

4. **Opportunity costs.** Managers tend to overlook opportunity costs, or to treat such costs as less important than out-of-pocket costs. Yet opportunity costs are just as real and important to making a correct decision, as are out-of-pocket costs. *Pay special attention to identifying and including opportunity costs in a decision analysis.*

LIFE-CYCLE COSTS AND TARGET COSTING

Life-cycle costing tracks and accumulates all product costs in the value chain from research and development and design of products and processes through production, marketing, distribution, and customer service. The value chain is the set of activities required to design, develop, produce, market, and service a product (or service). The terms "cradle-to-grave costing" and "womb-to-tomb costing" conveys the sense of fully capturing all costs associated with the product.

It focuses on minimizing locked-in costs, for example, by reducing the number of parts, promoting standardization of parts, and using equipment that can make more than one kind of product. Product life cycle is simply the time a product exists—from conception to abandonment. *Life-cycle costs* are all costs associated with the product for its entire life cycle. These costs include development (planning, design, and testing), manufacturing (conversion activities), and logistics support (advertising, distribution, warranty, and so on).

Because total customer satisfaction has become a vital issue in the new business setting, whole-life cost has emerged as the central focus of life-cycle cost management. *Whole-life cost* is the life-cycle cost of a product plus after-purchase (or post-purchase) costs that consumers incur, including operation, support, maintenance, and disposal. Since the costs a purchaser incurs after buying a product can be a significant percentage of whole-life costs and, thus, an important consideration in the purchase decision, managing activities so that whole-life costs are reduced can provide an important competitive advantage. NOTE: Cost reduction not cost control is the emphasis. Moreover, cost reduction is achieved by judicious analysis and management of activities.

Studies show that 90 percent or more of a product's costs are committed during the development stage. Thus, it makes sense to emphasize management of activities during this phase of a product's existence. Every dollar spent on premanufacturing activities is known to save $8-$10 on manufacturing and postmanufacturing activities. The real opportunities for cost reduction occur before manufacturing begins. Managers need to invest more in premanufacturing assets and dedicate more resources to activities in the early phases of the product life cycle so that overall whole-life costs can be reduced.

Target Costing Versus Cost-Plus Pricing

Life-cycle and whole-life cost concepts are associated with target costing and target pricing. A firm may determine that market conditions require that a product sell at a given target price. Hence, target cost can be determined by subtracting the desired unit profit margin from the target price. The cost reduction objectives of life-cycle and whole-life cost management can therefore be determined using target costing.

Thus, *target costing* becomes a particularly useful tool for establishing cost reduction goals. Toyota, for example, calculates the lifetime target profit for a new car model by multiplying a target profit ratio times the target sales. They then calculate the estimated profit by subtracting the estimated costs from target sales. Usually, (at this point), target profit is greater than estimated profit. The cost reduction goal is defined by the difference between the target profit and the estimated profit. Toyota then searches for cost reduction opportunities through better design of the new model. Toyota's management recognizes that more opportunities exist for cost reduction during product planning than in actual development and production.

The Japanese developed target costing to enhance their ability to compete in the global marketplace. This approach to product pricing differs significantly from the cost-based methods just described. Instead of first determining the cost of a product or service and then adding a profit factor to arrive at its price, target costing reverses the procedure. Target costing is a pricing method that involves (1) identifying the price at which a product will be competitive in the marketplace, (2) defining the desired profit to be made on the product, and (3) computing the target cost for the product by subtracting the desired profit from the competitive market price. The formula

Target Price — Desired Profit = Target Cost

Target cost is then given to the engineers and product designers, who use it as the maximum cost to be incurred for the materials and other resources needed to design and manufacture the product. It is their responsibility to create the product at or below its target cost.

Figure 1 compares the cost plus philosophy with the target costing philosophy.

FIGURE 1
COST-PLUS PRICING VERSUS TARGET COSTING

	Formula	*Implications*
Cost-plus pricing	Cost base + markup = selling price	• Cost is the base (given) • Markup is added (given) • The firm puts the product on the market and hopes the selling price is accepted
Pricing based on target costing	Target selling price - Desired profit = Target cost	• Markets determine prices (given) • Desired profit must be sustained for survival (given) • Target cost is the residual, the variable to be managed

EXAMPLE 9

A salesperson at Milmool Products Company has reported that a customer is seeking price quotations for two electronic components: a special-purpose battery charger (Product X101) and a small transistorized machine computer (Product Y101). Competing for the customer's order are one French company and two Japanese companies. The current market price ranges for the two products are as follows:

Product X101	$310—$370 per unit
Product Y101	$720—$820 per unit

The salesperson feels that if Milmool could quote prices of $325 for Product X101 and $700 for Product Y101, the company would get the order and gain a significant share of the global market for those goods. Milmool's usual profit markup is 25 percent of total unit cost. The company's design engineers and cost accountants put together the following specifications and costs for the new products:

Activity-based cost rates:

Materials handling activity	$1.30 per dollar of raw materials and purchased parts cost
Production activity	$3.50 per machine hour
Product delivery activity	$24.00 per unit of X101
	$30.00 per unit of Y101

	Product X101	*Product Y101*
Projected unit demand	26,000	18,000
Per unit data:		
Raw materials cost	$30.00	$65.00
Purchased parts cost	$15.00	$45.00
Manufacturing labor		
Hours	2.6	4.8
Hourly labor rate	$12.00	$15.00
Assembly labor		
Hours	3.4	8.2
Hourly labor rate	$14.00	$16.00
Machine hours	12.8	28.4

The company wants to address the following three questions:

1. What is the target cost for each product?
2. What is the projected total unit cost of production and delivery?
3. Using the target costing approach, should the company produce the products?

1. Target cost for each product:

Product X101 = $325.00 ÷ 1.25 = $260.00*
Product Y101 = $700.00 ÷ 1.25 = $560.00

*Target Price - Desired Profit = Target Cost

$325.00 - .25X = X

$325.00 = 1.25X

$$X = \frac{\$325.00}{1.25} = \$260.00$$

2. Projected total unit cost of production and delivery:

	Product X101	*Product Y101*
Raw materials cost	$ 30.00	$ 65.00
Purchased parts cost	15.00	45.00
Total cost of raw materials and parts	$ 45.00	$110.00
Manufacturing labor		
X101 (2.6 hours X $12.00)	31.20	
Y101 (4.8 hours x $15.00)		72.00
Assembly labor		
X101 (3.4 hours X $14.00)	47.60	
Y101 (8.2 hours X $16.00)		131.20
Activity-based costs		
Materials handling activity		
X101 ($45.00 x $1.30)	58.500	
Y101 ($110.00 x $1.30)		143.00
Production activity		
X101 (12.8 machine hours x $3.50)	44.80	
Y101 (28.4 machine hours X $3.50)		99.40
Product delivery activity		
X101	24.00	
Y101		30.00
Projected total unit cost	$251.10	$585.60

3. Production decision:

	Product X101	*Product Y101*
Target unit cost	$260.00	$560.00
Less: projected unit cost	251.10	585.60
Difference	$8.90	($25.60)

Product X101 can be produced below its target cost, so it should be produced. As currently designed, Product Y101 cannot be produced at or below its target cost; either it needs to be redesigned or the company should drop plans to make it.

COST ACCOUNTING IN ACTION— Companies Using Target Costing

The target costing approach to pricing is gaining ground in the U.S. Companies using this approach include Toyota, Boeing, Hondas, Eastman Kodak, Caterpillar, and DaimlerChrysler. They all claim that it has led to significant increases in profit.

CHAPTER SUMMARY

Not all costs are of equal importance in decision making, and managerial accountants must identify that costs that are relevant to a decision. The relevant costs are the expected future costs that differ between the decision alternatives. Therefore, the sunk costs are irrelevant since they are past and historical costs. The costs that continue regardless of the decision are irrelevant.

What are relevant are the incremental or differential costs. The relevant cost approach assists managerial accountants in making short-term, nonroutine decisions such as whether to accept a below-normal selling price, which products to emphasize, whether to make or buy, whether to sell or process further, how to formulate a bid price on a contract, and how to optimize utilization of capacity. Table 1 summarizes guidelines for typical short-tern decisions. Also presented is the cost-plus approach to pricing versus the target costing process.

TABLE 1

DECISION GUIDELINES

Decision	*Description*	*Decision Guidelines*
Special order	Should a discount-priced order be accepted when there is idle capacity?	If regular orders are not affected, accept order exceeds the incremental cost. Fixed costs are usually irrelevant.
Make or buy	Should a part be made or bought by a vendor?	Choose lower- cost option. Fixed costs are usually irrelevant. Often opportunity costs are present.
Closing a segment	Should a segment be dropped?	Compare loss in contribution margin with saving in fixed costs.
Sell or process further	Should joint products be sold at split- off or processed further?	Ignore joint costs. Process further if incremental revenue exceeds incremental cost.
Scarce resources	Which products should be emphasized with limited resources?	Emphasize products with highest contribution margin. per unit of scarce resource (e.g., CM per square foot).

CHAPTER 12
CAPITAL BUDGETING

Capital budgeting is the process of making long-term planning decisions for alternative investment opportunities. There are many investment decisions that the company may have to make in order to grow. Examples of capital budgeting applications are product line selection, keep or sell a business segment, lease or buy, and which asset to invest in.

After studying the material in this chapter, you will be able to

- List and describe the types and special features of capital budgeting decisions.
- Discuss the time value of money concept.
- Calculate, interpret, and evaluate five capital budgeting techniques.
- Select the best mix of projects with a limited capital spending budget.

WHAT ARE THE TYPES OF INVESTMENT PROJECTS?

There are typically two types of long-term investment decisions:

1. *Selection decisions* in terms of obtaining new facilities or expanding existing ones: Examples include:

   (a) Investments in property, plant, and equipment as well as other types of assets.

   (b) Resource commitments in the form of new product development, market research, introduction of a computer, refunding of long-term debt, and so on.

   (c) Mergers and acquisitions in the form of buying another company to add a new product line.

2. *Replacement decisions* in terms of replacing existing facilities with new ones. Examples include replacing an old machine with a high-tech machine.

WHAT ARE THE FEATURES OF INVESTMENT PROJECTS?

Long-term investments have three important features:

1. They typically involve a large amount of initial cash outlays which tend to have a long-term impact on the firm's future profitability. Therefore, this initial cash outlay needs to be justified on a cost-benefit basis.

2. There are expected recurring cash inflows (for example, increased revenues, savings in cash operating expenses, etc.) over the life of the investment project. This frequently requires considering the *time value of money.*

3. Income taxes could make a difference in the accept or reject decision. Therefore, income tax factors must be taken into account in every capital budgeting decision.

UNDERSTANDING THE CONCEPT OF TIME VALUE OF MONEY

A dollar now is worth more than a dollar to be received later. This statement sums up an important principle: money has a time value. The truth of this principle is not that inflation might make the dollar received at a later time worth less in buying power. The reason is that you could invest the dollar now and have more than a dollar at the specified later date.

Time value of money is a critical consideration in financial and investment decisions. For example, compound interest calculations are needed to determine future sums of money resulting from an investment. Discounting, or the calculation of present value, which is inversely related to compounding, is used to evaluate the future cash flow associated with capital budgeting projects. There are plenty of applications of time value of money in accounting and finance.

How Do You Calculate Future Values - How Money Grows?

A dollar in hand today is worth more than a dollar to be received tomorrow because of the interest it could earn from putting it in a savings account or placing it in an investment account. Compounding interest means that interest earns interest. For the discussion of the concepts of compounding and time value, let us define:

F_n = future value: the amount of money at the end of year n
P = principal
I = annual interest rate
n = number of years

Then,

F_1 = the amount of money at the end of year 1n
= principal and interest = $P + iP = P(1+i)$

F_2 = the amount of money at the end of year 2
= $F_1(1+i) = P(1+i)(1+i) = P(1+i)^2$

The future value of an investment compounded annually at rate i for n years is

$$F_n = P(1+i)^n = P \,.\, T1(i,n)$$

where T1(i,n) is the compound amount of $1 and can be found in Table 1 in the Appendix.

EXAMPLE 1

You place $1,000 in a savings account earning 8 percent interest compounded annually. How much money will you have in the account at the end of 4 years?

$$F_n = P(1+i)^n$$

$$F_4 = \$1{,}000\ (1 + 0.08)^4 = \$1{,}000\ T1(8\%,4\ \text{years})$$

From Table 1, the T1 for 4 years at 8 percent is 1.361.

Therefore, $F_4 = \$1{,}000\ (1.361) = \$1{,}361$.

EXAMPLE 2

You invested a large sum of money in the stock of Delta Corporation. The company paid a $3 dividend per share. The dividend is expected to increase by 20 percent per year for the next 3 years. You wish to project the dividends for years 1 through 3.

$$F_n = P(1+i)^n$$

$$F_1 = F_1 = \$3(1+0.2)^1 = \$3\ T1(20\%,1) = \$3\ (1.200) = \$3.60$$

$$F_2 = \$3(1+0.2)^2 = \$3\ T1(20\%,2) = \$3\ (1.440) = \$4.32$$

$$F_3 = \$3(1+0.2)^3 = \$3\ T1(20\%,3) = \$3\ (1.728) = \$5.18$$

Future Value of an Annuity

An annuity is defined as a series of payments (or receipts) of a fixed amount for a specified number of periods. Each payment is assumed to occur at the end of the period. The future value of an annuity is a compound annuity which involves depositing or investing an equal sum of money at the end of each year for a certain number of years and allowing it to grow.

Let S_n = the future value on an n-year annuity
A = the amount of an annuity

Then we can write

$$S_n = A(1+i)^{n-1} + A(1+i)^{n-2} + ... + A(1+i)^0$$

$$= A[(1+i)^{n-1}+(1+i)^{n-2}+ ... + (1+i)^0]$$

$$\boxed{S_n = A\bullet\sum_{t=0}^{n-1}(1+i)^t = A\bullet\left(\frac{(1+i)^n}{i}\right) = A\bullet T2(i, n)}$$

where T2(i,n) represents the future value of an annuity of $1 for n years compounded at i percent and can be found in Table 2 in the Appendix.

EXAMPLE 3

You wish to determine the sum of money you will have in a savings account at the end of 6 years by depositing $1,000 at the end of each year for the next 6 years. The annual interest rate is 8 percent. The T2(8%,6 years) is given in Table 2 as 7.336. Therefore,

S_6 = $1,000 T2(8%,6) = $1,000 (7.336) = $7,336

EXAMPLE 4

You deposit $30,000 semiannually into a fund for ten years. The annual interest rate is 8 percent. The amount accumulated at the end of the tenth year is calculated as follows:

S_n = A. T2(i, n)

Where A = $30,000
i = 8%/2 = 4%
n = 10 x 2 = 20

Therefore,

$$S_n = \$30,000\ T2(4\%, 20)$$
$$i = \$30,000\ (29.778) = \$893,340$$

What Is Present Value - How Much Money Is Worth Now?

Present value is the present worth of future sums of money. The process of calculating present values, or discounting, is actually the opposite of finding the compounded future value. In connection with present value calculations, the interest rate i is called the *discount rate*. The discount rate we use is more commonly called the *cost of capital*, which is the minimum rate of return required by the investor.

Recall that $F_n = P(1+i)^n$

Therefore,

$$P = \frac{F_n}{(1+i)^n} = F_n \bullet \left(\frac{1}{(1+i)^n}\right) = F_n \bullet T3(i, n)$$

Where T3(i,n) represents the present value of \$1 and is given in Table 3 in the Appendix.

EXAMPLE 5

You have been given an opportunity to receive \$20,000 6 years from now. If you can earn 10 percent on your investments, what is the most you should pay for this opportunity? To answer this question, you must compute the present value of \$20,000 to be received 6 years from now at a 10 percent rate of discount. F_6 is \$20,000, I is 10 percent, and n is 6 years. T3(10%,6) from Table 3 is 0.565.

$$P = \$20,000 \left(\frac{1}{(1+0.1)^6}\right) = \$20,000\ T3(10\%,6) = \$20,000(0.564) = \$11,280$$

This means that you can earn 10 percent on your investment, and you would be indifferent to receiving \$11,280 now or \$20,000 6 years from today since the amounts are time equivalent. In other words, you could invest \$11,300 today at 10 percent and have \$20,000 in 6 years.

Present Value of Mixed Streams of Cash Flows

The present value of a series of mixed payments (or receipts) is the sum of the present value of each individual payment. We know that the present value of each individual payment is the payment times the appropriate T3 value.

EXAMPLE 6

You are thinking of starting a new product line that initially costs $32,000. Your annual projected cash inflows are:

1	$10,000
2	$20,000
3	$5,000

If you must earn a minimum of 10 percent on your investment, should you undertake this new product line?

The present value of this series of mixed streams of cash inflows is calculated as follows:

Year	*Cash inflows*	*x T3(10%, n)*	*Present Value*
1	$10,000	0.909	$9,090
2	$20,000	0.826	$16,520
3	$5,000	0.751	$3,755
			$29,365

Since the present value of your projected cash inflows is less than the initial investment, you should not undertake this project.

Present Value of an Annuity

Interest received from bonds, pension funds, and insurance obligations all involve annuities. To compare these financial instruments, we need to know the present value of each. The present value of an annuity (P_n) can be found by using the following equation:

$$P_n = A \bullet \frac{1}{(1+i)^1} + A \bullet \frac{1}{(1+i)^2} + \ldots + A \bullet \frac{1}{(1+i)^n}$$

$$= A \bullet \left(\frac{1}{(1+i)^1} + \frac{1}{(1+i)^2} + \ldots + \frac{1}{(1+i)^n} \right)$$

$$P_n = A \bullet \sum_{t=0}^{n} \frac{1}{(1+i)^t} = A \bullet \left[\frac{1}{i} \left(1 - \frac{1}{(1+i)} \right) \right] = A \bullet T4(i,n)$$

where T4(i,n) represents the present value of an annuity of $1 discounted at i percent for n years and is found in Table 4 in the Appendix.

EXAMPLE 7

Assume that the cash inflows in Example 6 form an annuity of $10,000 for 3 years. Then the present value is

$$P_n = A \,.\, T4(i,n)$$

$$P_3 = \$10{,}000\ T4(10\%,\ 3\ \text{years}) = \$10{,}000\ (2.487) = \$24{,}870$$

Use of Financial Calculators and Spreadsheet Programs

There are many financial calculators that contain pre-programmed formulas to perform many present value and future applications. Furthermore, spreadsheet software such as *Excel* has built-in financial functions to perform many such applications.

HOW DO YOU MEASURE INVESTMENT WORTH?

Several methods of evaluating investment projects are as follows:

1. Payback period
2. Accounting rate of return (ARR)
3. Internal rate of return (IRR)
4. Net present value (NPV)
5. Profitability index (or present value index)

The NPV method and the IRR method are called *discounted cash flow (DCF) methods*. Each of these methods is discussed below.

Payback Period

The payback period measures the length of time required to recover the amount of initial investment. It is computed by dividing the initial investment by the cash inflows through increased revenues or cost savings.

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Annual Cash Inflows}}$$

EXAMPLE 8

Assume:

Cost of investment	\$18,000
Annual cash savings	\$3,000

Then, the payback period is:

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Cost savings}} = \frac{\$18{,}000}{\$3{,}000} = 6 \text{ years}$$

Decision rule: Choose the project with the shorter payback period. The rationale behind this choice is: The shorter the payback period, the less risky the project, and the greater the liquidity.

EXAMPLE 9

Consider the two projects whose after-tax cash inflows are not even. Assume each project costs \$1,000.

	Cash Inflow	
Year	*A(\$)*	*B(\$)*
1	100	500
2	200	400
3	300	300
4	400	100
5	500	
6	600	

When cash inflows are not even, the payback period has to be found by trial and error. The payback period of project A is 4 years (\$1,000= \$100 + \$200 + \$300 + \$400). The payback period of project B is 2 1/3 years (\$1,000 = \$500 + \$400 + \$100):

$$2 \text{ years} + \frac{\$100}{300} = \quad = 2\ 1/3 \text{ years}$$

Project B is the project of choice in this case, since it has the shorter payback period.

The advantages of using the payback period method of evaluating an investment project are that (1) it is simple to compute and easy to understand, and (2) it handles investment risk effectively.

The shortcomings of this method are that (1) it does not recognize the time value of money, and (2) it ignores the impact of cash inflows received after the payback period; essentially, cash flows after the payback period determine profitability of an investment.

Accounting Rate of Return

Accounting rate of return (ARR), also called *simple* or *unadjusted rate of return*, measures profitability from the conventional accounting standpoint by relating the required initial investment (I) -- or sometimes the average investment--to the future average annual income.

$$\text{ARR} = \frac{\text{Project's Average Annual Income}}{\text{Initial (or Average) Investment}}$$

Average investment is defined as follows:

$$\text{Average investment} = \frac{(\text{I} - \text{S})}{2} + \text{S}$$

$$\text{or simply } \frac{\text{I}}{2} \quad \text{if S} = 0$$

where I = initial (original) investment and S = salvage value.

Decision rule: Under the ARR method, choose the project with the higher rate of return.

EXAMPLE 10

Consider the following investment:

Initial investment (I)	\$6,500
Estimated life	20 years
Cash inflows per year	\$1,000
Depreciation per year (using straight line)	\$325
Salvage value (S)	0

The accounting rate of return for this project is:

$$\text{ARR} = \frac{\text{Average income}}{\text{Investment}} = \frac{\$1{,}000 - \$325}{\$6{,}500} = 10.4\%$$

If average investment is used, then:

$$\text{ARR} = \frac{\$1{,}000 - \$325}{\$6{,}500/2} = \frac{\$675}{\$3{,}250} = 20.8\%$$

The advantages of this method are that it is easily understood, simple to compute, and recognizes the profitability factor.

The shortcomings of this method are that it fails to recognize the time value of money, and it uses accounting data instead of cash flow data.

Internal Rate of Return

Internal rate of return (IRR), also called *time adjusted rate of return*, is defined as the rate of interest that equates I with the PV of future cash inflows.

In other words,

$$\boxed{\begin{array}{c}\text{at IRR, } I = PV \\ \\ (\text{or } NPV = 0)\end{array}}$$

Decision rule: Accept the project if the IRR exceeds the cost of capital. Otherwise, reject it.

EXAMPLE 11

Consider the following investment:

Initial investment	\$12,950
Estimated life	10 years
Annual cash inflows	\$3,000
Cost of capital (minimum required rate of return)	12%

We set the following equality (I = PV):

$$\$12,950 = \$3,000 \text{ T4(i,10 years)}$$

$$\text{T4(i,10 years)} = \frac{\$12,950}{\$3,000} = 4.317$$

which stands somewhere between 18 percent and 20 percent in the 10-year line of Table 4. The interpolation follows:

	PV of an Annuity if \$1 Factor	
	T4(I, 10 years)	
18%	4.494	4.494
IRR	4.317	
20%		4.192
Difference	0.177	0.302

Therefore,

$$\text{IRR} = 18\% + \frac{0.177}{0.302}(20\% - 18\%)$$

$$= 18\% + 0.586(2\%) = 18\% + 1.17\% = 19.17\%$$

Since the IRR of the investment is greater than the cost of capital (12 percent), accept the project.

The advantage of using the IRR method is that it does consider the time value of money and, therefore, is more exact and realistic than the ARR method.

The shortcomings of this method are that (1) it is time-consuming to compute, especially when the cash inflows are not even, although most financial calculators and PCs have a key to calculate IRR, and (2) it fails to recognize the varying sizes of investment in competing projects.

Net Present Value

Net present value (NPV) is the difference between the present value (PV)of the cash inflows and the initial investment (I) associated with a project:

$$NPV = PV - I$$

The present value of future cash flows is computed using the so-called *cost of capital* (or *minimum required rate of return)* as the discount rate. When cash inflows are uniform, the present value would be

$$PV = A\ T4\ (i, n)$$

where A is the amount of the annuity. The value of T4 is found in Table 4 of the Appendix.

Decision rule: If NPV is positive, accept the project. Otherwise reject it.

EXAMPLE 12

Assume the same data given in Example 11, and the net present value of the cash inflows is:

PV = A. T4(i,n)	
= \$3,000 T4(12%, 10 years)	
=\$3,000 (5.650)	\$16,950
Initial investment (I)	12,950
Net present value (NPV = PV-I)	\$4,000

Since the NPV of the investment is positive, the investment should be accepted.

The advantages of the NPV method are that it obviously recognizes the time value of money and it is easy to compute whether the cash flows form an annuity or vary from period to period.

Can a Computer Help?

Spreadsheet programs can be used in making IRR calculations. For example, *Excel* has a function IRR(values, guess). Excel considers negative numbers as cash outflows such as the initial investment, and positive numbers as cash inflows. Many financial calculators have similar features. As in Example 13, suppose you want to calculate the IRR of a \$12,950 investment (the value --12950 entered in year 0 that is followed by 10 monthly cash inflows of \$3,000). Using a guess of 12% (the value of 0.12), which is in effect the cost of capital, your formula would be @IRR(values, 0.12) and Excel would return 19.15%, as shown below.

Year 0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

$ (12,950)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000

IRR =	19.15%
NPV =	$4,000.67

Note: The *Excel* formula for NPV is NPV (discount rate, cash inflow values) + I, where I is given as a negative number.

YOU SHOULD REMEMBER

Summary of Decision Rules Using Both IRR and NPV Methods

Internal Rate of Return (IRR)

- Using the present-value tables (T3 or T4), financial calculator, or Excel, computer the IRR.
- If the IRR exceeds the cost of capital, accept the project; if not, reject the project.

Net Present Value (NPV)

- Calculate the NPV, using the cost of capital as the discount rate.
- If the NPV is positive, accept the project; otherwise, reject the project.

Profitability Index

The profitability index, also called *present value index*, is the ratio of the total PV of future cash inflows to the initial investment, that is,

$$\text{Profitability Index} = \frac{\text{PV}}{\text{I}}$$

This index is used as a means of ranking projects in descending order of attractiveness.

Decision rule: If the profitability index is greater than 1, then accept the project.

EXAMPLE 13

Using the data in Example 11, the profitability index is

$$\frac{PV}{I} = \frac{\$16{,}950}{\$12{,}950} = 1.31$$

Since this project generates $1.31 for each dollar invested (i.e., its profitability index is greater than 1), accept the project.

The profitability index has the advantage of putting all projects on the same relative basis regardless of size.

How to Select the Best Mix of Projects with a Limited Budget

Many firms specify a limit on the overall budget for capital spending. Capital rationing is concerned with the problem of selecting the mix of acceptable projects that provides the highest overall NPV. The profitability index is used widely in ranking projects competing for limited funds.

EXAMPLE 14

The Westmont Company has a fixed budget of $250,000. It needs to select a mix of acceptable projects from the following:

Projects	*I($)*	*PV($)*	*NPV($)*	*Profitability Index*	*Ranking*
A	70,000	112,000	42,000	1.60	1
B	100,000	145,000	45,000	1.45	2
C	110,000	126,500	16,500	1.15	5
D	60,000	79,000	19,000	1.32	3
E	40,000	38,000	-2,000	0.95	6
F	80,000	95,000	15,000	1.19	4

The ranking resulting from the profitability index shows that the company should select projects A, B, and D.

	I	*PV*
A	$70,000	$112,000
B	100,000	145,000
D	60,000	79,000
	$230,000	$336,000

Therefore,

NPV = $336,000 - $230,000 = $106,000

CHAPTER SUMMARY

We have examined the process of evaluating investment projects. We have also discussed five commonly used criteria for evaluating capital budgeting projects, including the net present value (NPV) and internal rate of return (IRR) methods. The problems that arise with capital rationing were addressed. Throughout this chapter, we assumed no income taxes. Nonprofit organizations such as hospitals typically are exempt from income taxes.

FINANCIAL TABLES

Table 1 Future Value of \$1 = T1(i,n)

Periods	4%	6%	8%	10%	12%	14%	20%
1	1.040	1.060	1.080	1.100	1.120	1.140	1.200
2	1.082	1.124	1.166	1.210	1.254	1.300	1.440
3	1.125	1.191	1.260	1.331	1.405	1.482	1.728
4	1.170	1.263	1.361	1.464	1.574	1.689	2.074
5	1.217	1.338	1.469	1.611	1.762	1.925	2.488
6	1.265	1.419	1.587	1.772	1.974	2.195	2.986
7	1.316	1.504	1.714	1.949	2.211	2.502	3.583
8	1.369	1.594	1.851	2.144	2.476	2.853	4.300
9	1.423	1.690	1.999	2.359	2.773	3.252	5.160
10	1.480	1.791	2.159	2.594	3.106	3.707	6.192
11	1.540	1.898	2.332	2.853	3.479	4.226	7.430
12	1.601	2.012	2.518	3.139	3.896	4.818	8.916
13	1.665	2.133	2.720	3.452	4.364	5.492	10.699
14	1.732	2.261	2.937	3.798	4.887	6.261	12.839
15	1.801	2.397	3.172	4.177	5.474	7.138	15.407
16	1.873	2.540	3.426	4.595	6.130	8.137	18.488
17	1.948	2.693	3.700	5.055	6.866	9.277	22.186
18	2.026	2.854	3.996	5.560	7.690	10.575	26.623
19	2.107	3.026	4.316	6.116	8.613	12.056	31.948
20	2.191	3.207	4.661	5.728	9.646	13.743	38.338
30	3.243	5.744	10.063	17.450	29.960	50.950	237.380
40	4.801	10.286	21.725	45.260	93.051	188.880	1469.800

Table 2 Future Value of an Annuity of $1 = T2(i,n)

Periods	4%	6%	8%	10%	12%	14%	20%
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	2.040	2.060	2.080	2.100	2.120	2.140	2.200
3	3.122	3.184	3.246	3.310	3.374	3.440	3.640
4	4.247	4.375	4.506	4.641	4.779	4.921	5.368
5	5.416	5.637	5.867	6.105	6.353	6.610	7.442
6	6.633	6.975	7.336	7.716	8.115	8.536	9.930
7	7.898	8.394	8.923	9.487	10.089	10.730	12.916
8	9.214	9.898	10.637	11.436	12.300	13.233	16.499
9	10.583	11.491	12.488	13.580	14.776	16.085	20.799
10	12.006	13.181	14.487	15.938	17.549	19.337	25.959
11	13.486	14.972	16.646	18.531	20.655	23.045	32.150
12	15.026	16.870	18.977	21.385	24.133	37.271	39.580
13	16.627	18.882	21.495	24.523	28.029	32.089	48.497
14	18.292	21.015	24.215	27.976	32.393	37.581	59.196
15	20.024	23.276	27.152	31.773	37.280	43.842	72.035
16	21.825	25.673	30.324	35.950	42.753	50.980	87.442
17	23.698	28.213	33.750	40.546	48.884	59.118	105.930
18	25.645	30.906	37.450	45.600	55.750	68.394	128.120
19	27.671	33.760	41.446	51.160	63.440	78.969	154.740
20	29.778	36.778	45.762	57.276	75.052	91.025	186.690
30	56.085	79.058	113.283	164.496	241.330	356.790	1181.900
40	95.026	154.762	259.057	442.597	767.090	1342.000	7343.900

*Payments (or receipts) at the *end* of each period.

Table 3 Present Value of \$1 = T3(i,n)

PERIODS	3%	4%	5%	6%	7%	8%	10%	12%	14%	16%	18%	20%	22%	24%	25%	26%	28%	30%	40%
1	.9709	.9615	.9524	.9434	.9346	.9259	.9091	.8929	.8772	.8621	.8475	.8333	.8197	.8065	.8000	.7937	.7813	.7692	.7143
2	.9426	.9246	.9070	.8900	.8734	.8573	.8264	.7972	.7695	.7432	.7182	.6944	.6719	.6504	.6400	.6299	.6104	.5917	.5102
3	.9151	.8890	.8638	.8396	.8163	.7938	.7513	.7118	.6750	.6407	.6086	.5787	.5507	.5245	.5120	.4999	.4768	.4552	.3644
4	.8885	.8548	.8227	.7921	.7629	.7350	.6830	.6355	.5921	.5523	.5158	.4823	.4514	.4230	.4096	.3968	.3725	.3501	.2603
5	.8626	.8219	.7835	.7473	.7130	.6806	.6209	.5674	.5194	.4761	.4371	.4019	.3700	.3411	.3277	.3149	.2910	.2693	.1859
6	.8375	.7903	.7462	.7050	.6663	.6302	.5645	.5066	.4556	.4104	.3704	.3349	.3033	.2751	.2621	.2499	.2274	.2072	.1328
7	.8131	.7599	.7107	.6651	.6227	.5835	.5132	.4523	.3996	.3538	.3139	.2791	.2486	.2218	.2097	.1983	.1776	.1594	.0949
8	.7894	.7307	.6768	.6274	.5820	.5403	.4665	.4039	.3506	.3050	.2660	.2326	.2038	.1789	.1678	.1574	.1388	.1226	.0678
9	.7664	.7026	.6446	.5919	.5439	.5002	.4241	.3606	.3075	.2630	.2255	.1938	.1670	.1443	.1342	.1249	.1084	.0943	.0484
10	.7441	.6756	.6139	.5584	.5083	.4632	.3855	.3220	.2697	.2267	.1911	.1615	.1369	.1164	.1074	.0992	.0847	.0725	.0346
11	.7224	.6496	.5847	.5268	.4751	.4289	.3505	.2875	.2366	.1954	.1619	.1346	.1122	.0938	.0859	.0787	.0662	.0558	.0247
12	.7014	.6246	.5568	.4970	.4440	.3971	.3186	.2567	.2076	.1685	.1372	.1122	.0920	.0757	.0687	.0625	.0517	.0429	.0176
13	.6810	.6006	.5303	.4688	.4150	.3677	.2897	.2292	.1821	.1452	.1163	.0935	.0754	.0610	.0550	.0496	.0404	.0330	.0126
14	.6611	.5775	.5051	.4423	.3878	.3405	.2633	.2046	.1597	.1252	.0985	.0779	.0618	.0492	.0440	.0393	.0316	.0254	.0090
15	.6419	.5553	.4810	.4173	.3624	.3152	.2394	.1827	.1401	.1079	.0835	.0649	.0507	.0397	.0352	.0312	.0247	.0195	.0064
16	.6232	.5339	.4581	.3936	.3387	.2919	.2176	.1631	.1229	.0930	.0708	.0541	.0415	.0320	.0281	.0248	.0193	.0150	.0046
17	.6050	.5134	.4363	.3714	.3166	.2703	.1978	.1456	.1078	.0802	.0600	.0451	.0340	.0258	.0225	.0197	.0150	.0116	.0033
18	.5874	.4936	.4155	.3503	.2959	.2502	.1799	.1300	.0946	.0691	.0508	.0376	.0279	.0208	.0180	.0156	.0118	.0089	.0023
19	.5703	.4746	.3957	.3305	.2765	.2317	.1635	.1161	.0829	.0596	.0431	.0313	.0229	.0168	.0144	.0124	.0092	.0068	.0017
20	.5537	.4564	.3769	.3118	.2584	.2145	.1486	.1037	.0728	.0514	.0365	.0261	.0187	.0135	.0115	.0098	.0072	.0053	.0012
21	.5375	.4388	.3589	.2942	.2415	.1987	.1351	.0926	.0638	.0443	.0309	.0217	.0154	.0109	.0092	.0078	.0056	.0040	.0009
22	.5219	.4220	.3418	.2775	.2257	.1839	.1228	.0826	.0560	.0382	.0262	.0181	.0126	.0088	.0074	.0062	.0044	.0031	.0006
23	.5067	.4057	.3256	.2618	.2109	.1703	.1117	.0738	.0491	.0329	.0222	.0151	.0103	.0071	.0059	.0049	.0034	.0024	.0004
24	.4919	.3901	.3101	.2470	.1971	.1577	.1015	.0659	.0431	.0284	.0188	.0126	.0085	.0057	.0047	.0039	.0027	.0018	.0003
25	.4776	.3751	.2953	.2330	.1842	.1460	.0923	.0588	.0378	.0245	.0160	.0105	.0069	.0046	.0038	.0031	.0021	.0014	.0002
26	.4637	.3607	.2812	.2198	.1722	.1352	.0839	.0525	.0331	.0211	.0135	.0087	.0057	.0037	.0030	.0025	.0016	.0011	.0002
27	.4502	.3468	.2678	.2074	.1609	.1252	.0763	.0469	.0291	.0182	.0115	.0073	.0047	.0030	.0024	.0019	.0013	.0008	.0001
28	.4371	.3335	.2551	.1956	.1504	.1159	.0693	.0419	.0255	.0157	.0097	.0061	.0038	.0024	.0019	.0015	.0010	.0006	.0001
29	.4243	.3207	.2429	.1846	.1406	.1073	.0630	.0374	.0224	.0135	.0082	.0051	.0031	.0020	.0015	.0012	.0008	.0005	.0001
30	.4120	.3083	.2314	.1741	.1314	.0994	.0573	.0334	.0196	.0116	.0070	.0042	.0026	.0016	.0012	.0010	.0006	.0004	.0000
40	.3066	.2083	.1420	.0972	.0668	.0460	.0221	.0107	.0053	.0026	.0013	.0007	.0004	.0002	.0001	.0001	.0001	.0000	.0000

Table 4 Present Value of an Annuity of $1 = T4(i,n)

Periods	3%	4%	5%	6%	7%	8%	10%	12%	14%	16%	18%	20%	22%	24%
1	.9709	.9615	.9524	.9434	.9346	.9259	.9091	.8929	.8772	.8621	.8475	.8333	.8197	.8065
2	1.9135	1.8861	1.8594	1.8334	1.8080	1.7833	1.7355	1.6901	1.6467	1.6052	1.5656	1.5278	1.4915	1.4568
3	2.8286	2.7751	2.7232	2.6730	2.6243	2.5771	2.4869	2.4018	2.3216	2.2459	2.1743	2.1065	2.0422	1.9813
4	3.7171	3.6299	3.5460	3.4651	3.3872	3.3121	3.1699	3.0373	2.9137	2.7982	2.6901	2.5887	2.4936	2.4043
5	4.5797	4.4518	4.3295	4.2124	4.1002	3.9927	3.7908	3.6048	3.4331	3.2743	3.1272	2.9906	2.8636	2.7454
6	5.4172	5.2421	5.0757	4.9173	4.7665	4.6229	4.3553	4.1114	3.8887	3.6847	3.4976	3.3255	3.1669	3.0205
7	6.2303	6.0021	5.7864	5.5824	5.3893	5.2064	4.8684	4.5638	4.2883	4.0386	3.8115	3.6046	3.4155	3.2423
8	7.0197	6.7327	6.4632	6.2098	5.9713	5.7466	5.3349	4.9676	4.6389	4.3436	4.0776	3.8372	3.6193	3.4212
9	7.7861	7.4353	7.1078	6.8017	6.5152	6.2469	5.7590	5.3282	4.9464	4.6065	4.3030	4.0310	3.7863	3.5655
10	8.5302	8.1109	7.7217	7.3601	7.0236	6.7101	6.1446	5.6502	5.2161	4.8332	4.4941	4.1925	3.9232	3.6819
11	9.2526	8.7605	8.3064	7.8869	7.4987	7.1390	6.4951	5.9377	5.4527	5.0286	4.6560	4.3271	4.0354	3.7757
12	9.9540	9.3851	8.8633	8.3838	7.9427	7.5361	6.8137	6.1944	5.6603	5.1971	4.7932	4.4392	4.1274	3.8514
13	10.6350	9.9856	9.3936	8.8527	8.3577	7.9038	7.1034	6.4235	5.8424	5.3423	4.9095	4.5327	4.2028	3.9124
14	11.2961	10.5631	9.8986	9.2950	8.7455	8.2442	7.3667	6.6282	6.0021	5.4675	5.0081	4.6106	4.2646	3.9616
15	11.9379	11.1184	10.3797	9.7122	9.1079	8.5595	7.6061	6.8109	6.1422	5.5755	5.0916	4.6755	4.3152	4.0013
16	12.5611	11.6523	10.8378	10.1059	9.4466	8.8514	7.8237	6.9740	6.2651	5.6685	5.1624	4.7296	4.3567	4.0333
17	13.1661	12.1657	11.2741	10.4773	9.7632	9.1216	8.0216	7.1196	6.3729	5.7487	5.2223	4.7746	4.3908	4.0591
18	13.7535	12.6593	11.6896	10.8276	10.0591	9.3719	8.2014	7.2497	6.4674	5.8178	5.2732	4.8122	4.4187	4.0799
19	14.3238	13.1339	12.0853	11.1581	10.3356	9.6036	8.3649	7.3658	6.5504	5.8775	5.3162	4.8435	4.4415	4.0967
20	14.8775	13.5903	12.4622	11.4699	10.5940	9.8181	8.5136	7.4694	6.6231	5.9288	5.3527	4.8696	4.4603	4.1103
21	15.4150	14.0292	12.8212	11.7641	10.8355	10.0168	8.6487	7.5620	6.6870	5.9731	5.3837	4.8913	4.4756	4.1212
22	15.9369	14.4511	13.1630	12.0416	11.0612	10.2007	8.7715	7.6446	6.7429	6.0113	5.4099	4.9094	4.4882	4.1300
23	16.4436	14.8568	13.4886	12.3034	11.2722	10.3711	8.8832	7.7184	6.7921	6.0442	5.4321	4.9245	4.4985	4.1371
24	16.9355	15.2470	13.7986	12.5504	11.4693	10.5288	8.9847	7.7843	6.8351	6.0726	5.4509	4.9371	4.5070	4.1428
25	17.4131	15.6221	14.0939	12.7834	11.6536	10.6748	9.0770	7.8431	6.8729	6.0971	5.4669	4.9476	4.5139	4.1474
26	17.8768	15.9828	14.3752	13.0032	11.8258	10.8100	9.1609	7.8957	6.9061	6.1182	5.4804	4.9563	4.5196	4.1511
27	18.3270	16.3296	14.6430	13.2105	11.9867	10.9352	9.2372	7.9426	6.9352	6.1364	5.4919	4.9636	4.5243	4.1542
28	18.7641	16.6631	14.8981	13.4062	12.1371	11.0511	9.3066	7.9844	6.9607	6.1520	5.5016	4.9697	4.5281	4.1566
29	19.1885	16.9837	15.1411	13.5907	12.2777	11.1584	9.3696	8.0218	6.9830	6.1656	5.5098	4.9747	4.5312	4.1585
30	19.6004	17.2920	15.3725	13.7648	12.4090	11.2578	9.4269	8.0552	7.0027	6.1772	5.5168	4.9789	4.5338	4.1601
40	23.1148	19.7928	17.1591	15.0463	13.3317	11.9246	9.7791	8.2438	7.1050	6.2335	5.5482	4.9966	4.5439	4.1659

CHAPTER 13
CAPITAL BUDGETING AND INCOME TAXES

Income taxes make a difference in many capital budgeting decisions. In other words, the project which is attractive on a before-tax basis may have to be rejected on an after-tax basis. Income taxes typically affect both the amount and the timing of cash flows. Since net income, not cash inflows, is subject to tax, after-tax cash inflows are not usually the same as after-tax net income.

After studying the material in this chapter, you will be able to

- State how income tax factors affect investment decisions.
- Calculate after-tax cash flows - initial outlay, differential cash flows, and terminal cash flow.
- List and illustrate the types of depreciation methods.
- Discuss the effect of Modified Accelerated Cost Recovery System (MACRS) on capital budgeting decisions.

HOW DO INCOME TAXES AFFECT INVESTMENT DECISIONS?

Income taxes make a difference in many capital budgeting decisions. The project which is attractive on a before-tax basis may have to be rejected on an after-tax basis and vice versa. Income taxes typically affect both the amount and the timing of cash flows. Since net income, not cash inflows, is subject to tax, after-tax cash inflows are not usually the same as after-tax net income.

How To Calculate After-Tax Cash Flows

Let us define:

S = Sales
E = Cash operating expenses
d = Depreciation
t = Tax rate

Note: Before-tax cash inflows (or cash savings) = **(S – E)** and

Net income = **(S - E – d)**

By definition,

$$\text{After-tax cash inflows} = \text{Before-tax cash inflows} - \text{Taxes}$$
$$= (S - E) - (S - E - d)(t)$$

Rearranging gives the short-cut formula:

$$\text{After-tax cash inflows} = (S - E)(1 - t) + (d)(t)$$
$$= \text{After-tax cash inflows from operations} + \text{Tax shield}$$

Or

$$= \text{After-tax net income} + \text{depreciation}$$
$$= (S - E - d)(1 - t) + d$$

As can be seen, the deductibility of depreciation from sales in arriving at taxable net income reduces income tax payments and thus serves as a *tax shield*.

Tax shield = Tax savings on depreciation = (d)(t)

EXAMPLE 1

Assume:

S = $12,000
E = $10,000
d = $500 per year using the straight line method
t 30%

Then,

After-tax cash inflow = ($12,000 - $10,000) (1 - .3) + ($500)(.3)
= ($2,000)(.7) + ($500)(.3)
= $1,400 + $150 = $1,550

Note that a tax shield = tax savings on depreciation = (d)(t)
= ($500)(.3) = $150

Since the tax shield is dt, the higher the depreciation deduction, the higher the tax savings on depreciation. Therefore, an accelerated depreciation method (such as double-declining balance) produces higher tax savings than the straight-line method. Accelerated methods produce higher present values for the tax savings which may make a given investment more attractive.

EXAMPLE 2

The Navistar Company estimates that it can save $2,500 a year in cash operating costs for the next ten years if it buys a special-purpose machine at a cost of $10,000. No residual value is expected. Depreciation is by straight-line. Assume that the income tax rate is 30%, and the after-tax cost of capital (minimum required rate of return) is 10%. Should the company buy the machine? Use the NPV method.

Step 1: Calculate after-tax cash savings:

Note that depreciation by straight-line is $10,000/10 = $1,000 per year. Thus,

After-tax cash savings = (S - E) (1 - t) + (d)(t)
= $2,500(1 - .3) + $1,000(.3)
= $1,750 + $300 = $2,050

Step 2: To see if this machine should be purchased, the net present value can be calculated.

PV = $2,050 T4(10%, 10 years) = $2,050 (6.145)=$12,597.25

Thus, NPV = PV - I = $12,597.25 - $10,000 = $2,597.25

Since NPV is positive, the machine should be bought.

EXAMPLE 3

The CFO of a small appliance maker estimates the sales revenue, cash operating expenses and cash inflows before taxes shown in columns 1, 2, and 3 of the table below, if it buys a high tech machine at a cost of $1,000,000. No residual value is expected. Life is 5 years. Depreciation is by straight-line. Assume that the income tax rate is 35%, and the after-tax cost of capital (minimum required rate of return) is 10%. Should the company buy the machine? Use the NPV method.

The process of arriving at net cash flow after taxes are shown in columns 4, 5, 6, 7, and 8.

Year	Sales (S) **(1)**	Cash Operating Expenses (E) **(2)**	Cash Inflow Before Taxes (S-E) **(3)**=(1)-(2)	Depreciation (noncash Expense) (d) **(4)**= 1,000,000/5	Net Income Before Taxes **(5)**=(3)-(4)	Income Taxes **(6)** = .35 x (5)	Net Income After Taxes **(7)**=(5)-(6)	Cash Inflow After Taxes **(8)**=(3)-(6) or (7)+(4)
1	$ 1,000,000	$ 625,000	$ 375,000	$ 200,000	$ 175,000	$ 61,250	$ 113,750	$ 313,750
2	$ 900,000	$ 610,000	$ 290,000	$ 200,000	$ 90,000	$ 31,500	$ 58,500	$ 258,500
3	$ 925,000	$ 635,000	$ 290,000	$ 200,000	$ 90,000	$ 31,500	$ 58,500	$ 258,500
4	$ 930,000	$ 605,000	$ 325,000	$ 200,000	$ 125,000	$ 43,750	$ 81,250	$ 281,250
5	$ 825,000	$ 557,000	$ 268,000	$ 200,000	$ 68,000	$ 23,800	$ 44,200	$ 244,200

The NPV of the machine can be calculated using Table 3, as shown below.

Year	Cash Inflow After Taxes	T3 at 10% Table value	PV
1	$ 313,750	0.909	$ 285,199
2	$ 258,500	0.826	$ 213,521
3	$ 258,500	0.751	$ 194,134
4	$ 281,250	0.683	$ 192,094
5	$ 244,200	0.621	$ 151,648
			$ 1,036,596

Thus, NPV = PV - I = $1,036,596 - $1,000,000 = $36,596. Since NPV is positive, the machine should be bought.

EXAMPLE 4

Shalimar Corporation has provided its revenues and cash operating costs (excluding depreciation) for the old and the new machine, as follows:

	Revenue	*Annual Cash Operating Costs*	*Net Profit before Depreciation and Taxes*
Old machine	$150,000	$70,000	$80,000
New machine	$180,000	$60,000	$120,000

Assume that the annual depreciation of the old machine and the new machine will be $30,000 and $50,000, respectively. Assume further that the tax rate is 46%.

To arrive at net profit after taxes, we first have to deduct depreciation expense from the net profit before depreciation and taxes, as follows:

	Net Profits after Taxes	*Add Depreciation*	*After-Tax Cash Inflows*
Old machine	($80,000-$30,000)(1-0.46)=$27,000	$30,000	$57,000
New machine	($120,000-$50,000)(1-0.46)=$37,800	$50,000	$87,800

Subtracting the after-tax cash inflows of the old machine from the cash inflows of the new machine results in the relevant, or incremental, cash inflows for each year.

Therefore, in this example, the relevant or incremental cash inflows for each year are \$87,800 - \$57,000 = \$30,800.

Alternatively, the incremental cash inflows after taxes can be computed, using the following simple formula:

After-tax incremental cash inflows = (increase in revenues)(1-tax rate)
- (increase in cash charges)(1-tax rate)
+ (increase in depreciation expenses)(tax rate)

EXAMPLE 5

Using the data in Example 4, after-tax incremental cash inflows for each year are:

Increase in revenue x (1 - tax rate):	
(\$180,000 - \$150,000)(1 - 0.46)	\$16,200
- Increase in cash charges x (1-tax rate):	
(\$60,000 - \$70,000)(1 - 0.46)	- (5,400)
+ Increase in depreciation expense x	
tax rate: (\$50,000-\$30,000)(0.46)	9,200
	\$30,800

THE LONG AND SHORT OF AFTER – TAX CASH FLOWS

In general, a project's cash flows will fall into one of three categories: (1) the initial investment, (2) the differential flows over the project's life, (3) the terminal cash flow. The capital-budgeting criteria, which was discussed in the previous chapter will use these cash flows as inputs.

Initial Investment - Incremental Investment

The initial investment involves the immediate cash outlay necessary to purchase the asset and put it in operating order. This amount includes the cost of installing the asset (the asset's purchase price plus any expenses associated with transportation or installation) and any nonexpense cash outlays, such as increased working capital requirements. If we are considering a new sales outlet, there might be additional cash flows associated with investment in working capital in the form of increased inventory and cash necessary to operate the sales outlet. While these cash flows are not included in the cost of the asset or even expensed on the books, they must be included in our analysis.

The after-tax cost of expense items incurred as a result of new investment must also be included as cash outflows--for example, any training expenses or special engineering expenses that would not have been incurred otherwise. Finally, if the investment decision is a replacement decision, the cash inflow associated with the selling price of the old asset, in addition to any tax effects resulting from its sale, must be accounted for.

Items included in the initial outlay calculation are summarized in Table 1.

TABLE 1
INITIAL INVESTMENT

1. Purchase price of asset and installation cost
2. Additional expenses on an after-tax basis (for example, training expenses)
3. Additional nonexpense outlays incurred (for example, working capital investments)
4. In a replacement decision, the after-tax cash flow associated with the disposal of the old asset

Tax Effects of Disposal

In general, gains and losses (i.e., the disposal value minus the book value) on disposal of equipment are taxed in the same way as ordinary gains and losses. Immediate disposal of the old equipment results in a loss that is fully tax deductible from current income. The loss (the excess of the book value over the disposal value) must be computed to isolate its effect on current income tax, but the total cash inflow is the disposal value (sales price) *plus* the current income tax benefit. *Note:* The terms, *disposal value, residual value, salvage value,* and *sales price* are used interchangeably.

In short, there are *three* possible tax situations dealing with the sale of an old asset:

1. The old asset is sold for a price *above* the book (undepreciated) value is considered recapture of depreciation (or gain) and taxed at the corporate tax rate. If, for example, the old machine was originally purchased for $15,000, had a book value of $10,000 and was sold for $14,000, assuming the firm's tax rate is 40 percent, the taxes on gain (due from recapture of depreciation) would be ($14,000 - $10,000)(.40), or $1,600. The after-tax cash inflow then is $14,000 - $1,600 = **$12,400.**

2. The old asset is sold for its book value. In this case no taxes result, as there is neither a gain nor a loss in the asset's sale. The after-tax cash inflow is the selling price (disposal value) = **$10,000**.

3. The old asset is sold for *less than* its book value. In this case the difference between the undepreciated book value and the salvage value of the asset is used to offset ordinary income and thus results in tax savings. Assume that the machine was sold for $8,000, while its book value is $10,000. *Two* cash inflows are connected with this sale.

a. A $10,000 cash inflow in the form of the sales price, and

b. A $800 cash inflow in the form of a reduction in income taxes, resulting from the tax shield provided by the loss sustained on the sale, just like the tax shield provided by depreciation deduction, as computed as follows:

Book value		$10,000
Selling price		8,000
Loss		2,000
Tax shield	x .40	$800

Thus, the total cash inflow from the disposal, on an after-tax basis, is **$8,800** ($8,000 + $800).

EXAMPLE 6

Assume a company in the 40 percent tax bracket contemplating the purchase of a new machine to be used in oil and gas drilling for $30,000. It has a useful life of five years and will be depreciated using the straight-line method. The new machine will replace an existing machine originally purchased for $30,000, 10 years ago, which currently has five more years of expected useful life. The existing machine will generate $2,000 of depreciation expenses for each of the next five years, at which time the book value will be equal to zero. To put the new machine in running order, it is necessary to pay shipping charges of $2,000 and installation charges of $3,000. Because the new machine will work faster than the old one, it will require an increase in goods-in-process inventory of $3,000. Finally, the old machine can be sold to a scrap dealer for $15,000.

The installed cost of the new machine would be the $30,000 cost plus $2,000 shipping and $3,000 installation fees, for a total of $35,000. Additional outflows are associated with taxes incurred on the sale of the old machine and with increased investment in inventory. Although the old machine has a book value of $10,000, it could be sold for $15,000. The increased taxes on a gain (from recapture of depreciation) will be equal to the sales price of the old machine less its book value times the firm's tax rate, or ($15,000 - $10,000)(.4), or $2,000.

The increase in goods-in-process inventory of $3,000 must also be considered part of the initial outlay, which will be recovered at the termination of the project. In effect, the firm invests $3,000 in inventory now, resulting in an initial cash outlay, and liquidates this inventory in five years, resulting in a $3,000 cash inflow at the end of the project. The total outlays associated with the new machine are $35,000 for its installed cost, $2,000 in increased taxes, and $3,000 in investment in inventory, for a total of $40,000. This is somewhat offset by the sale of the old machine for $15,000. Thus, the initial investment associated with this project is $25,000, as shown in Table 2.

TABLE 2
CALCULATION OF INITIAL INVESTMENT

Out-of-pocket outlays:	
Installed cost of machine	$35,000
Increased taxes from sale of old machine (15,000-$10,000)(.4)	2,000
Increased investment in inventory	3,000
Total Outlays	$40,000
Inflows:	
Salvage value of old machine	15,000
Initial outlay	$25,000

Differential Flows over the Project's Life

The differential cash flows over the project's life involve the incremental after-tax cash flows resulting from increased revenues, plus labor or material savings, and reductions in selling expenses. Any major repair and overhaul costs must be included. Furthermore, an adjustment for the incremental change in taxes should be made, including any increase in taxes that might result from increased profits or any tax savings from an increase in depreciation expenses. Increased depreciation expenses affect tax-related cash flows by reducing taxable income and thus lowering taxes. Table 3 lists some of the factors that might be involved in determining a project's differential cash flows.

TABLE 3
DIFFERENTIAL CASH FLOWS ON AN AFTER-TAX BASIS

1. Incremental revenue
2. Labor and material savings
3. Increases in overhead or overhaul incurred
4. In a replacement decision depreciation tax shield on an incremental basis

In the example, assume further that purchasing the machine is expected to reduce salaries by $10,000 per year and fringe benefits by $1,000 annually, because it will take only one man to operate, whereas the old machine requires two operators. In addition, the cost of defects will fall from $8,000 per year to $3,000. However, maintenance expenses will increase by $4,000 annually. The annual depreciation on this new machine is $7,000 per year, while the depreciation expense lost with the sale of the old machine is $2,000 for each of the next five years. Annual depreciation on the new machine is calculated using the straight-line method.

Since the depreciation on the old machine is $2,000 per year, the increased depreciation will be from $2,000 per year to $7,000 per year, or an increase of $5,000 per year. Although this increase in depreciation expenses is not a cash flow item, it does affect cash flows by reducing taxable income, which in turn reduces taxes.

To determine the annual net cash flows resulting from the acceptance of this project, the net savings before taxes using both book income and cash flows must be found. The additional taxes are then calculated based upon the before-tax book profit. Table 4 shows the determination of the differential cash flows on an after-tax basis. Thus, the differential cash flows over the project's life are $9,200.

TABLE 4
CALCULATION OF DIFFERENTIAL CASH FLOWS

	Book Income	*Cash Flow*
Savings: Reduced salary	$10,000	$10,000
Reduced fringe benefits	1,000	1,000
Reduced defects ($8,000-$3,000)	5,000	5,000
Costs: Increased maintenance expense	-4,000	-4,000
Increased depreciation expense ($7,000-$2,000)	-5,000	
Net savings before taxes	$7,000	$12,000
Taxes (40%)	-2,800	-2,800
Net cash flow after taxes		$ 9,200

Terminal Cash Flow

The calculation of the terminal cash flow is much simpler than the preceding two calculations. Flows associated with the project's termination generally include the salvage value of the project plus or minus any taxable gains or losses associated with its sales. In addition to the salvage value, there may be a cash outlay associated with the project termination, such as shutdown costs. Finally, any working capital outlay ---inventory investments --required at the initiation of the project will be recovered by liquidating the inventory. Table 5 lists some of the factors that might affect a project's terminal cash flow.

In this example, the depreciated book value and salvage value of the machine both are equal to zero. However, there will be a cash flow associated with the recapture of the initial outlay of work-in-process inventory of $3,000. This flow is generated from the liquidation of the $3,000 investment in work-in-process inventory. Therefore, the expected total terminal cash flow equals $3,000.

In summary, the company would have (1) an initial outlay of $25,000, (2) differential cash flows during years 1 through 5 of $9,200, and (3) a terminal cash flow at the end of year 5 of $3,000.

TABLE 5
TERMINAL CASH FLOW ON AN AFTER-TAX BASIS

1. The after-tax salvage value of the project

2. Any cash outlays necessary to terminate the project
3. Recapture of nonexpense outlays required at the project's outset (for example, working capital investments)

TYPES OF DEPRECIATION METHODS

We saw that depreciation provided the tax shield in the form of (d)(t). Among the commonly used depreciation methods are straight-line and accelerated methods. The two major accelerated methods are sum-of-the years'-digits (SYD) and double-declining-balance (DDB).

Straight-Line Method

This is the easiest and most popular method of calculating depreciation. It results in equal periodic depreciation charges. The method is most appropriate when an asset's usage is uniform from period to period, as is the case with furniture. The annual depreciation expense is calculated by using the following formula:

$$\text{Depreciation expense} = \frac{\text{Cost - salvage value}}{\text{Number of years of useful life}}$$

EXAMPLE 7

An auto is purchased for $20,000 and has an expected salvage value of $2,000. The auto's estimated life is 8 years. Its annual depreciation is calculated as follows:

$$\text{Depreciation expense} = \frac{\text{Cost - salvage value}}{\text{Number of years of useful life}}$$

$$= \frac{\$20{,}000 - \$2{,}000}{8 \text{ years}} = \$2{,}250/\text{year}$$

An alternative means of computation is to multiply the depreciable cost ($18,000) by the annual depreciation rate, which is 12.5 percent in this example. The annual rate is calculated by dividing the number of years of useful life into one (1/8 = 12.5%). The result is the same: $18,000 x 12.5% = $2,250.

Sum-of-the Years'-Digits (SYD) Method

In this method, the number of years of life expectancy is enumerated in reverse order in the numerator, and the denominator is the sum of the digits. For example, if the life expectancy of a machine is 8 years, write the numbers in reverse order: 8, 7, 6, 5, 4, 3, 2, 1. The sum of these digits is 36, or (8 + 7 + 6 + 5 + 4 + 3 + 2 + 1). Thus, the fraction for the first year is 8/36, while the fraction for the last year is 1/36. The sum of the eight fractions equals 36/36, or 1. Therefore, at the end of 8 years, the machine is completely written down to its salvage value.

The following formula may be used to quickly find the sum-of-the-years' digits (S):

$$S = \frac{(N)(N+1)}{2}$$

where N represents the number of years of expected life.

EXAMPLE 8

In Example 6, the *depreciable* cost is $18,000 ($20,000 - $2,000). Using the SYD method, the computation for each year's depreciation expense is

$$S = \frac{(N)(N+1)}{2} = \frac{8(9)}{2} = 72/2 = 36$$

Year	*Fraction*	*x*	*Depreciation Amount ($)*	*=*	*Depreciation Expense*
1	8/36		$18,000		$4,000
2	7/36		18,000		3,500
3	6/36		18,000		3,000
4	5/36		18,000		2,500
5	4/36		18,000		2,000
6	3/36		18,000		1,500
7	2/36		18,000		1,000
8	1/36		18,000		500
Total					$18,000

Double-Declining-Balance (DDB) Method

Under this method, depreciation expense is highest in the earlier years and lower in the later years. First, a depreciation rate is determined by doubling the straight-line rate. For example, if an asset has a life of 10 years, the straight-line rate is 1/10 or 10 percent, and the double-declining rate is 20 percent. Second, depreciation expense is computed by multiplying the rate by the book value of the asset at the beginning of each year. Since book value declines over time, the depreciation expense decreases each successive period.

This method *ignores* salvage value in the computation. However, the book value of the fixed asset at the end of its useful life cannot be below its salvage value.

EXAMPLE 9

Assume the data in Example 7. Since the straight-line rate is 12.5 percent (1/8), the double-declining-balance rate is 25 percent (2 x 12.5%). The depreciation expense is computed as follows:

Year	*Book Value at Beginning of Year*	*x*	*Rate (%)*	*=*	*Depreciation Expense*	*Year-end Book Value*
1	$20,000		25%		$5,000	$15,000
2	15,000		25		3,750	11,250
3	11,250		25		2,813	8,437
4	8,437		25		2,109	6,328
5	6,328		25		1,582	4,746
6	4,746		25		1,187	3,559
7	3,559		25		890	2,669
8	2,669		25		667	2,002

Note: If the original estimated salvage value had been $2,100 instead of $2,000, the depreciation expense for the eighth year would have been $569 ($2,669 - $2,100) rather than $667, since the asset cannot be depreciated below its salvage value.

Units of Production Method

Under this method, depreciation varies with output.

$$\text{Depreciation per unit} = \frac{\text{Cost} - \text{salvage value}}{\text{Estimated total units that can be produced in the asset's lifetime}}$$

Depreciation = units of output for year x depreciation per unit

EXAMPLE 10

The cost of a machine is $11,000 with a salvage value of $1,000. The estimated total units are 5,000. The units produced in the first year are 400.

$$\text{Depreciation per unit} = \frac{\$11{,}000 - \$1{,}000}{5{,}000} = \$2 \text{ per unit}$$

Depreciation in year 1 = 400 units x $2 = $800

Which Method To Use

1. Of course, over the life of the fixed asset, the total depreciation charge will be the same no matter what depreciation method is used; only the timing of the tax savings will differ.

2. The depreciation method used for financial reporting purposes should be realistic for that type of fixed asset. For example, depreciation on an automobile may be based on mileage.

3. The accelerated methods such as SYD and DDB are advantageous for tax purposes since higher depreciation charges in the earlier years result in less income and thus less taxes. The tax savings may then be invested for a return.

HOW DOES MACRS AFFECT INVESTMENT DECISIONS?

Although traditional depreciation methods still can be used for computing depreciation for book purposes, 1981 saw a new way of computing depreciation deductions for tax purposes. The current rule is called the *Modified Accelerated Cost Recovery System* (MACRS) rule, as enacted by Congress in 1981 and then modified somewhat in 1986 under the Tax Reform Act of 1986. This rule is characterized as follows:

1. The concept of useful life is abandoned and depreciation deductions are accelerated by placing all depreciable assets into one of eight age property classes. It calculates deductions, based on an allowable percentage of the asset's original cost (See Tables 6 and 7). With a shorter asset tax life than useful life, the company would be able to deduct depreciation more quickly and save more in income taxes in the earlier years, thereby making an investment more attractive. The rationale behind the system is that this way the government encourages the company to invest in facilities and increase its productive capacity and efficiency. (Remember that the higher d is, the larger the tax shield (d)(t)).

2. Since the allowable percentages in Table 7 add up to 100%, there is no need to consider the salvage value of an asset in computing depreciation. *Note:* MACRS for assets with lives of 10 years or fewer is based on the 200%-declining-balance method of depreciation. Thus, an asset with a 3-year life would have a straight-line rate of 33-1/3%, or a double-declining-balance rate of 66-2/3%.

3. The company may elect the straight line method. The straight-line convention must follow what is called the *half-year convention*. This means that the company can deduct only half of the regular straight-line depreciation amount in the first year. The reason for electing to use the MACRS optional straight-line method is that some firms may prefer to stretch out depreciation deductions using the straight-line method rather than to

accelerate them. Those firms are the ones that just start out or have little or no income and wish to show more income on their income statements.

4. If an asset is disposed of before the end of its class life, the half-year convention allows half the depreciation for that year (early disposal rule).

EXAMPLE 11

Assume that a machine falls under a 3-year property class under MACRS and costs $3,000 initially. The straight line option under MACRS differs from the traditional straight line method in that under this method the company would deduct only $500 depreciation in the first year and the fourth year ($3,000/3 years =$1,000; $1,000/2=$500). The table below compares the straight line with half-year convention with the MACRS deduction.

Year	***Straight line (half-year) Depreciation***	*Cost*		*MACRS %*	***MACRS Deduction***
1	**$ 500**	$3,000	x	33.3%	**$ 999**
2	**1,000**	3,000	x	44.5	**1,335**
3	**1,000**	3,000	x	14.8	**444**
4	**500**	3,000	x	7.4	**222**
	$3,000				**$3,000**

EXAMPLE 12

A machine costs $10,000. Annual cash inflows are expected to be $5,000. The machine will be depreciated using the MACRS rule and will fall under the 3-year property class. The cost of capital after taxes is 10%. The estimated life of the machine is 5 years. The salvage value of the machine at the end of the fifth year is expected to be $1,200. The tax rate is 30%. Should you buy the machine? Use the NPV method.

The formula for computation of after-tax cash inflows (S - E)(1 - t)+ (d)(t) needs to be computed separately. The NPV analysis can be performed as follows:

				Present value Factor @ 10%	*Present value*
(S-E)(1 -t):					
	$5,000 For 5 years	$5,000 (1 - .3) = **$3,500** for **5** years	**$3.500**	3.791(a)	$13,268.50

(d)(t):

	Year	*Cost*		*MACRS %*	*d*	*(d)(t)*		
	1	$10,000	x	33.3%	$3,330	**$999**	.909(b)	908.09
	2	$10,000	x	44.5	4,450	**1,335**	.826(b)	1,102.71
	3	$10,000	x	14.8	1,480	**444**	.751(b)	333.44
	4	$10,000	x	7.4	740	**222**	. 683(b)	151.63
Salvage value:								
		$1,200 in year 5:		$1,200(1-.3) = **$840**(c) in year **5**		**$840**	.621(b)	521.64
				Present value (PV)				$16,286.01

(a) T4 (10%, 4 years) = 3.170 (from Table 4).
(b) T3 values (year 1, 2, 3, 4, 5) obtained from Table 3.
(c) Any salvage value received under the MACRS rules is a *taxable gain* (the excess of the selling price over book value, $1,200 in this example), since the book value will be zero at the end of the life of the machine.

Since NPV = PV - I = $16,286.01 - $10,000 = $6,286.01 is positive, the machine should be bought.

CHAPTER SUMMARY

Since income taxes could make a difference in the accept or reject decision, tax factors must be taken into account in every decision. Although the traditional depreciation methods still can be used for computing depreciation for book purposes, 1981 saw a new way of computing depreciation deductions for tax purposes. The rule is called the *modified accelerated cost recovery system* (MACRS). It was enacted by Congress in 1981 and then modified somewhat in 1986 under the Tax Reform Act of 1986. We presented an overview of the traditional depreciation methods and illustrated the use of MACRS.

TABLE 6
MODIFIED ACCELERATED COST RECOVERY SYSTEM
CLASSIFICATION OF ASSETS

Property class

Year	*3-year*	*5-year*	*7-year*	*10-year*	*15-year*	*20-year*
1	33.3%	20.0%	14.3%	10.0%	5.0%	3.8%
2	44.5	32.0	24.5	18.0	9.5	7.2
3	14.8a	19.2	17.5	14.4	8.6	6.7
4	7.4	11.5a	12.5	11.5	7.7	6.2
5		11.5	8.9a	9.2	6.9	5.7
6		5.8	8.9	7.4	6.2	5.3
7			8.9	6.6a	5.9a	4.9
8			4.5	6.6	5.9	4.5a
9				6.5	5.9	4.5
10				6.5	5.9	4.5
11				3.3	5.9	4.5
12					5.9	4.5
13					5.9	4.5
14					5.9	4.5
15					5.9	4.5
16					3.0	4.4
17						4.4
18						4.4
19						4.4
20						4.4
21						2.2
Total	100%	100%	100%	100%	100%	100%

a. Denotes the year of changeover to straight-line depreciation.

TABLE 7
MACRS TABLES BY PROPERTY CLASS

MACRS Property Class & Depreciation Method	*Useful Life (ADR Midpoint Life) "a"*	*Examples of Assets*
3-year property 200% declining balance	*4 years or less*	*Most small tools are included; the law specifically excludes autos and light trucks from this property class.*
5-year property 200% computers, declining balance	*More than 4 years to Less than 10 years*	*Autos and light trucks, typewriters, copiers, duplicating equipment, heavy general- purpose trucks, and research and experimentation equipment are included.*
7-year property 200% and declining balance	*10 years or more to less than 16 years*	*Office furniture and fixtures most items of machinery and equipment used in production are included*
10-year property 200% declining balance	*16 years or more to less than 20 years*	*Various machinery and equipment, such as that used in petroleum distilling and refining and in the milling of grain, are included.*
15-year property 150% declining balance	*20 years or more to less than 25 years*	*Sewage treatment plants telephone and electrical distribution facilities, and land improvements are included.*
20-year property 150% declining balance	*25 years or more*	*Service stations and other real property with an ADR midpoint life of less than 27.5 years are included.*
27.5-year property Straight-line	*Not applicable*	*All residential rental property is included*
31.5-year property Straight-line	*Not applicable*	*All nonresidential property is included.*

"a" The term ADR midpoint life means the "useful life" of an asset in a business sense; the appropriate ADR midpoint lives for assets are designated in the tax Regulations.

CHAPTER 14
PROCESS COSTING,
COST ALLOCATION, AND
JOINT PRODUCT COSTING

Process costing is a cost accumulation system that aggregates manufacturing costs by departments or by production processes. Total manufacturing costs are accumulated by two major categories, direct materials and conversion costs (the sum of direct labor and factory overhead applied). Unit cost is determined by dividing the total costs charged to a cost center by the output of that cost center. In that sense, the unit costs are averages.

Process costing is appropriate for companies that produce a continuous mass of like units through a series of operations or processes. Process costing is generally used in such industries as petroleum, chemicals, oil refinery, textiles, and food processing.

After studying the material in this chapter, you will be able to

- Describe what process costing is about and how to choose the right system for cost accumulations.
- List the types of product flow.
- Explain the steps in process costing calculations.
- Distinguish between the weighted-average and first-in, first-out (FIFO) process costing methods.
- Compute equivalent units of production by both the weighted-average and FIFO methods.
- Determine unit costs under both the weighted-average and FIFO methods.
- Explain how three methods of allocating service department costs to production departments work.
- Account for joint and byproduct costs.

IDENTIFICATION OF SYSTEM PROBLEMS AND CHOICE OF A SYSTEM

Since the unit costs under process costing are more of averages, the process costing system requires less bookkeeping than a job order costing system. A lot of companies prefer to use a process costing system for this reason. However, before any particular system is chosen, the principal system problem(s) must be identified in a broader perspective.

Typically, which method of costing to use depends more upon the characteristics of the production process and the types of products manufactured. If the products are alike and move from one processing department to another in a continuous chain, a process costing method is desirable. If, however, there are significant differences among the costs of the various products, a process costing system would not provide adequate product cost information and thus a job order costing method is more appropriate.

For example, a job order costing system would invariably be used if the customer paid for the specific item, production order, or service on the basis of its cost, which is often the case in repair shops and custom work.

Of course, some companies might find it necessary to use some kind of hybrid of these two systems, depending on how a product flows through the factory. For example, in a parallel processing situation, which is discussed later, some form of hybrid of the two systems has proved to be the optimal system choice.

Those industries that are most suitable for process costing have the following characteristics:

1. Production quantity is uniform.
2. A given order does not affect the production process.
3. Customer orders are filled from the manufacturer's stock.
4. There is continuous mass production through an assembly line approach.
5. There exists a standardization of the process and product.
6. There is a desire to implement cost control on a departmental basis rather than on a customer or product basis.
7. There is continuity of demand for the output.
8. Quality standards can be implemented on a departmental basis such as on-line inspection as processing proceeds.

PRODUCT FLOW

There are essentially three different types of product (processing) flow in processing. They are sequential, parallel, and selective, as shown in Figure 1. In a sequential flow, each product item manufactured goes through the same set of operations. For example, in a textile industry, a typical plant operates a dyeing department as well as a spinning department. The dyeing department receives yarn from the spinning department and dyes it, then transfers it to finished goods. Thus, the product flow in textile operations is sequential.

In a parallel flow, certain portions of work are done simultaneously and then brought together in a particular process in chain form. The portions of work done simultaneously may require a job order type of costing, since they may be needed to keep track of the differences in costs between the portions of work done simultaneously. Canned food processing industries employ this type of system. In manufacturing fruit cocktail products, different kinds of fruits are peeled and processed simultaneously in different locations in a factory. They are then brought together in a final process or processes for canning and transfer to finished goods inventory.

Finally, in a selective flow, the product goes through a selected set of processing departments within a factory, depending on the desired final product. Meat processing and petroleum refining falls in this category. Take meat processing, for example. After initial butchering, some of the meat product goes to grinding, then to packing, and then to finished goods; and some goes to smoking, packaging and finished goods in that order. The selected flows may take a wide variety of forms.

STEPS IN PROCESS COSTING CALCULATIONS

There are basically five steps to be followed in accounting for process costs. They are summarized below.

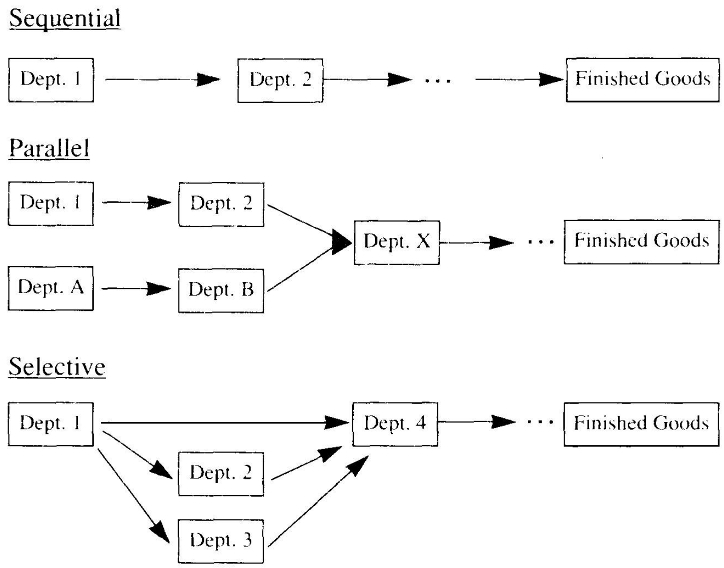
(1) Summarize the flow of physical units.

The first step of the accounting provides a summary of all units on which some work was done in the department during the period. *Input must equal output*. This step helps to detect lost units during the process. The basic relationship may be expressed in the following equation:

Beginning inventory + units started for the period = units completed and transferred out + ending inventory

FIGURE 1

TYPES OF PROCESSING FLOW



(2) Compute output in terms of equivalent units

In order to determine the unit costs of the product in a processing environment, it is important to measure the total amount of work done during an accounting period. A special problem arises in processing industries in connection with how to deal with work still in process, that is, the work partially completed at the end of the period. The partially completed units are measured on an equivalent whole-unit basis for process-costing purposes.

Equivalent units are a measure of how many whole units of production are represented by the units completed plus the units partially completed. For example, 100 units that are 60%completed are the equivalent of 60 completed units in terms of conversion costs.

(3) Summarize the total costs to be accounted for by cost categories.

This step summarizes the total costs assigned to the department during the period.

(4) Compute the unit costs per equivalent unit.

The unit costs per equivalent is computed as follows:

$$\text{Unit cost} = \frac{\text{Total costs incurred during the period}}{\text{Equivalent units of production during the period}}$$

(5) Apply total costs to units completed and transferred out and to units in ending work – in - process.

COST-OF-PRODUCTION REPORT

The process-costing method uses what is called the cost-of-production report. It summarizes both total and unit costs charged to a department and indicates the allocation of total costs between work-in-process inventory and the units completed and transferred out to the next department or the finished goods inventory. The cost-of-production report covers all five steps described above. It is also the source for monthly journal entries as well as a convenient compilation from which cost data may be presented to management.

Ledger Accounts Used in A Process System

In order to assign costs to processing departments and to compute unit costs of output, it is desirable to have at least one work-in- process inventory account for each production center, such as:

Work-in-process inventory: Department A
Work-in-process inventory: Department B

It may be useful to have subdivisions of each of these departmental accounts for every input factor for which unit costs are to be computed and reported. The following are examples (See Figure 1):

Work-in-process, Department A: Materials
Work-in-process, Department B: Conversion costs

Process-Cost Computation: No Beginning Inventory

The first illustration of unit-cost computations under a process system assumes for simplicity that there is no beginning work-in-process inventory. A company produces and sells a chemical product that is processed in two departments. In Department A the basic materials are crushed, powdered, and mixed. In Department B the product is tested, packaged, and labeled, and before being transferred to finished goods inventory.

Assume the following for Production Department A for May. Materials are added when production is begun; therefore, all finished units and all units in the ending work-in-process inventory will have received a full complement of materials.

Actual production costs:

Direct materials used, 18,000 gallons costing	$27,000.
Direct labor and factory overhead,	$25,000.

Actual production:

Completed and transferred to Production Department B, 8,000 gallons.
Ending work-in-process, 10,000 gallons, 20% complete as to conversion.

(1) Summarize the flow of physical units.

To be accounted for:	
Added this period	18,000 gallons
Accounted for as follows:	
Completed this period	8,000 gallons
In process, end of period	10,000
Total	18,000 gallons

(2) Compute output in terms of equivalent units

	Materials (gal.)	**Conversion Cost**
Units completed	8,000	8,000
Ending work-in-process (10,000 gallons)		
100% of materials.	10,000	
20% of conversion cost		2,000
Equivalent units produced	18,000	10,000

Steps (3) through (5)

Cost of Production

	Total Cost	**Equivalent Production (gal.)**	**Unit Cost**
Material	$27,000	18,000	$1.50
Conversion Cost	25,000	10.000	2.50
To be accounted for	$52,000		$4.00
Ending Work-in-process:			
Materials	$15,000	10,000	$1.50
Conversion Cost	5,000	2,000	2.50
Total Work-in-process	$20,000		
Completed and Transferred	$32,000	8,000	4.00
Total Accounted for	$52,000		

Ending Work-in-process:			
Materials	$15,000	10,000	$1.50
Conversion Cost	5,000	2,000	2.50
Total Work in process	$20,000		
Completed and Transferred	$32,000	8,000	4.00
Total Accounted for	$52,000		

Journal Entries

Work-in-process, Department A: Materials	27,000	
Materials inventory		27,000

To record cost of materials issued during May

Work-in-process, Department A: Conversion cost	25,000	
Accrued payroll and various other accounts		25,000

To record cost of direct labor and factory overhead during May

Work-in-process, Department B: Cost transferred in.,……………………… 32,000
Work-in-process, Department A: Materials
(8,000 gallons x $1.50)…………………………………………...………….. 12,000
Work-in-process, Department A: Conversion cost
(8,000 gallons x $2.50)………………………………………………………. 20,000

After the preceding entries have been posted, the balances of the work-in-process accounts of
Department A will be as follows:

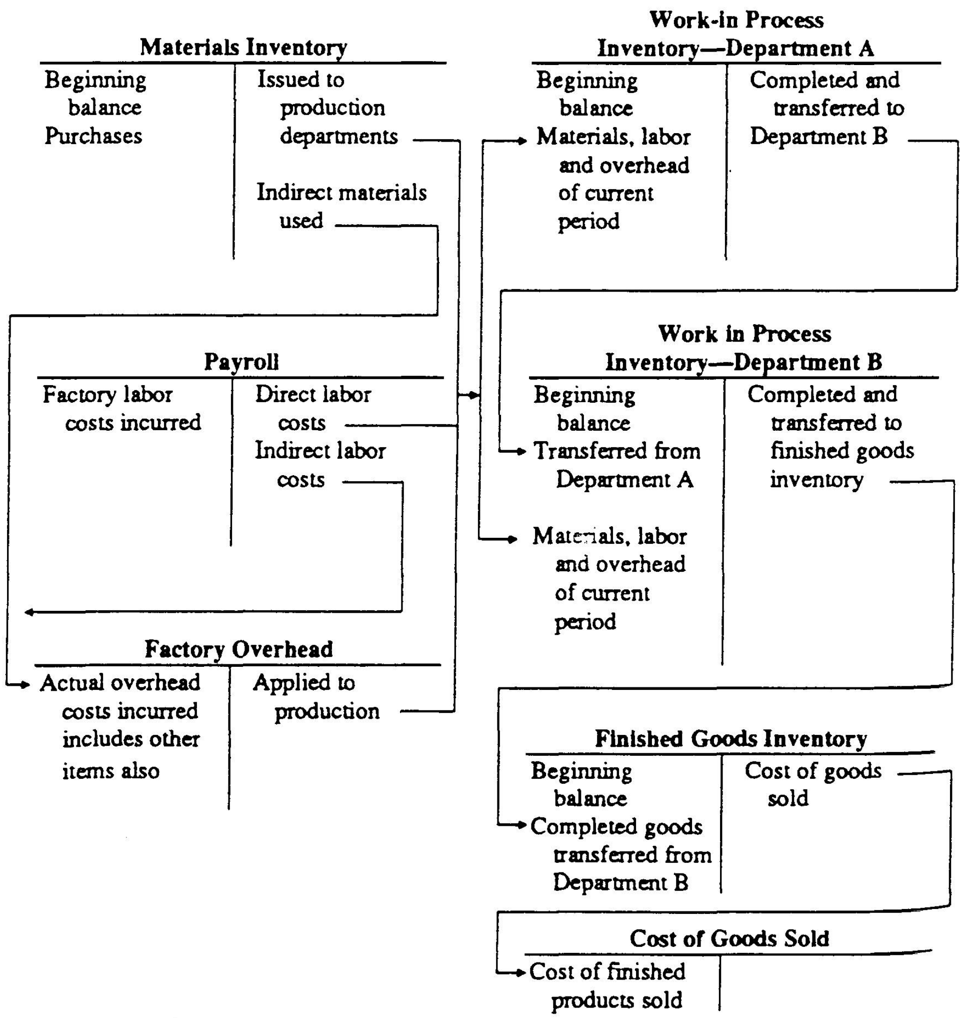
Work-in-process, Department A: Materials	$15,000
Work-in-process, Department A: Conversion costs	5,0000

Note: Transferred-in costs are similar to materials added at a point during the process because both attach to (become part of) the product at that point, which is usually the beginning of the process. Computations for transferred-in costs are usually separate from those for other direct materials costs and conversion costs.

These balances agree with the results computed in the cost-of-production report.

FIGURE 2

PROCESS COST SYSTEM: FLOW CHART OF LEDGER RELATIONSHIPS



WEIGHTED AVERAGE VS. FIRST-IN FIRST-OUT (FIFO)

When there is a beginning inventory of work in process, the production completed during the period comes from different batches, some from work partially completed in a prior period and some from new units started in the current period. Since costs tend to vary from period to period, each batch may carry different unit costs. There are two ways to treat the costs of the beginning inventory. One is weighted average costing and the other is first-in-first-out (FIFO).

Under the weighted average method of costing, both unit costs of work in process at the beginning of the period are combined with current production units started in the current period and their costs and an average cost is computed. In determining equivalent production units, no distinction is made between work partially completed in the prior period and the units started and completed in the current period. Thus, there is only one average cost for goods completed.

Equivalent units under weighted average costing may be computed as follows:

Units completed + [ending work in process x degree of completion (%)].

Under FIFO, on the other hand, beginning work in process inventory costs are separated from added costs applied in the current period. Thus, there are two unit costs for the period: (1) beginning work in process units completed and (2) units started and completed in the same period. Under FIFO, the beginning work in process is assumed to be completed and transferred first. Equivalent units under FIFO costing may be computed as follows:

Units completed + [Ending work in process x degree of completion (%)]
- [Beginning work in process x degree of completion (%)]

EXAMPLE 1

To illustrate, the following data relate to the activities of Department A during the month of January:

	Units
Beginning Work-in-process	
(all materials; 66,67% complete as to conversion)	1,500
Started This Period	5,000
Available	6,500
Completed and Transferred	5,500
Ending Work-in-process	
(all materials; 60% complete as to conversion)	1,000
Accounted for	6,500

Equivalent production in Department A for the month is computed, using weighted average costing, as follows:

	Materials	*Conversion Costs*

Units completed and Transferred	5,500	5,500
Ending Work-in-process		
Materials (100%)	1,000	
Conversion Costs (60%)		600
Equivalent Production	6,500	6,100

Equivalent production in Department A for the month is computed, using **FIFO** costing, as follows:

	Materials	*Conversion Costs*
Units Completed and Transferred	5,500	5,500
Ending Work-in-process		
Materials (100%)	1,000	
Conversion Costs (60%)		600
Equivalent Production for Weight Average	6,500	6,100
Minus: Beginning Work-in-process		
Materials (100%)	1,500	
Conversion Costs (66.67%)		1,000
Equivalent Production for FIFO	5,000	5,100

In the following example, we will illustrate, step by step, the weighted average and FIFO methods.

EXAMPLE 2

The Portland Cement Manufacturing Company, Inc. manufactures cement. Its processing operations involve quarrying, grinding, blending, packing and sacking. For cost accounting and control purposes, there are four processing centers: Raw Material No. 1, Raw Material No. 2, Clinker, and Cement. Separate cost of production reports are prepared in detail with respect to the foregoing cost centers. The following information pertains to the operation of Raw Material No. 2 Department for July 20A:

	Materials	*Conversion*
Units in Process July 1		
800 Bags	Complete	60% Complete
Costs	$12,000	$56,000
Units Transferred Out		
40,000 Bags		
Current Costs	$41,500	$521,500
Units in Process July 31		
5,000 Bags	Complete	30% Complete

Using weighted-average costing and FIFO costing, we will compute the following:

(a) Equivalent production units and unit costs by elements.
(b) Cost of work-in-process for July.
(c) Cost of units completed and transferred.

(a) Computation of Output in Equivalent Units

	Physical Flow	Materials	Conversion
Work-in-process, beginning	800(60%)		
Units Transferred in	44,200*		
Units to Account for	45,500		
Units Completed & Transferred Out	40,000	40,000	40,000
Work-in-process, ending	5,000 (30%)	5,000	1,500
Units Accounted for	45,000		
Equivalent Units Used for Weighted-average Costing		45,000	41,500
Less: Old equivalent units for work done on beginning inventory in prior period		800	480
Equivalent Units Used for **FIFO**		44,200	41,020

* (40,000 + 5,000) - 800 = 45,000 - 800 = 44,200

COST OF PRODUCTION REPORT, WEIGHTED AVERAGE
Raw Materials No. 2 Department
for the Month Ended July 31, 20x1

	Work-in-process Beginning	Current Costs	Total Costs	Equivalent Units	Average Unit Cost
Materials	$12,000	$41,500	$53,500	45,000	$1.1889
Conversion Costs	56,000	521,500	577,500	41,500	13.9157
	$68,000	563,000	631,000		$15.1046

Cost of Goods Completed 40,000 x $15.1046		$604,184
Work-in-process, Ending:		
Materials 5,000 x	$5,944.50	

$1.1899		
Conversion 1,500 x 13.9156	20,873.55	26,818.05
		$631.000 (rounded)

COST OF PRODUCTION REPORT, FIFO

Raw Materials No. 2 Department
for the Month Ended July 31, 20x1

	Total Costs	Equivalent Units	Unit Costs
Work-in-process, beginning	$68,000		
Current costs:			
Materials	41,500	44,200	$.9389
Conversion Costs	521,500	41,020	12.7133
Total costs to account for	$631,000		$13.6522

Cost of goods completed 40,000 in units:		
Work-in-process, beginning to be transferred out first	$68,000	
Additional costs to complete 800 x (1-.6)* x $12.7133	4,068.26	
Cost of goods started and completed this month		
39,200 x $13.6522	535,166.24	$607,234.50
Work-in-process, end:		
Materials 5,000 x $.9389		$4,694.50
Conversion 1,500 x $12.7133	19,069.95	23,764.45
Total costs accounted for		$631,000 (rounded)

*((1-.6)=.4 means that it takes an additional 40% work to complete 800 WIP work-in-process units.

A summary follows:

	Weighted Average		FIFO	
	Materials	Conversion	Materials	Conversion
(a) Equivalent units	45,000	41,500	44,200	41,020
Unit costs	$1.1889	$13.9157	$9,389	$12.7133
(b) Cost of work-in-process	$26,818.05		$23,764.45	
(c) Cost of units completed and transferred	$604,184		$607,234.50	

Note the difference in unit costs between the weighted-average and FIFO methods. From the perspective of cost control, FIFO costing is superior to the weighted-average method because of its focus on current period costs.

ESTIMATING DEGREE OF COMPLETION

Estimating the degree of completion for work in process is critical. Inaccurate estimates will undoubtedly lead to inaccurate computation of unit costs especially for conversion. Estimating the degree of completion is usually easier for materials than for processing or conversion costs. The degree of completion for materials is normally 100 percent unless the material is added during or at the end of any given process. On the other hand, the stage of completion for conversion costs requires specific knowledge about the conversion sequence. The sequence consists of a standard number of processing operations or a standard number of days, weeks or months for mixing, refining, aging and finishing.

Thus, in order to estimate the degree of completion for conversion, one has to determine what proportions of the total effort, in terms of direct labor and overhead, is needed to complete one unit or one batch of production. Industrial engineers should be able to measure the proportion of conversion needed with reasonable accuracy. In practice, instead of putting effort into estimating the actual stage of completion, the assumption is often made that work still in process at the end of the accounting period is 50 percent complete. At the other extreme, some firms ignore the work in process completely and show no work in process inventory account. This approach is acceptable only if the work in process inventory is insignificant in amount or if it remains relatively constant in size.

Application of Factory Overhead Using Predetermined Rates

As discussed previously, it is common to charge factory overhead to work in process using a predetermined overhead application rate, since the actual overhead is not available until the end of the period. In process costing, the overhead is usually applied only at the end of the period; however, in many cases the duration of the time period desired for product costing and control information is not the same as the time period that is satisfactory for financial reporting. When the time periods are equal and actual overhead costs can be obtained on a timely basis, the application of overhead to each processing unit's production is not necessary, and using actual overhead is preferable.

When production and overhead costs vary significantly from period to period, however, it is desirable to apply overhead using predetermined application rates. This provides representative unit costs especially if we are dealing with a seasonal business. The rates may be based on direct labor hours, machine hours, direct labor costs, direct material costs, production volume, etc. The use of departmental rates reflecting the different characteristics of different processing departments are certainly desirable. For example, it may be most realistic to apply overhead on a direct labor basis in one department and machine hours in another department.

MANAGERIAL USE OF PROCESS COST DATA

A process costing system, just like a job order costing system, is essentially a cost accumulation system which produces the unit manufacturing cost for a given process. Per unit manufacturing costs are used primarily for product costing, inventory valuation, and income determination. Equally important, however, the per unit cost data are vital for pricing purposes. They are used not only for pricing finished products but also for product mix strategies to maximize profits, and determining optimal production methods.

Perhaps the most effective way to fully utilize process cost data is to integrate the output into the standard costing system of the firm. Blended with standard costing, the process cost data provides the basis for which management can judge the cost performance of a processing department as a cost center in all categories of costs such as direct material, direct labor and overhead. An increase in any one of these cost components is a "red light" to management as to a possible inefficiency in a given department. This topic will be explored in further detail in Chapter 8 (Responsibility Accounting, Standard Costs, and Variances).

The process cost data also aids management in many processing decisions. In a multi-product and joint product situation, management is often faced with the decision as to whether to sell the product at what is called the split-off point or process it further in the hope of increased revenues. In addition, for external reporting purposes, process cost data, whether in total or in units, will help management allocate joint manufacturing costs to different joint products so that they can produce income statements by products.

In designing the system to meet the needs of both product costing and cost control, management should identify the cost centers. Cost centers may be assigned to each division, department or section. The number of processing departments as cost centers will depend on the detail desired by management. Cost centers should typically be set up along organizational lines for control purposes. Management must weigh the cost/benefit relationship in deciding on the number of cost centers desired.

PROCESS COSTING AND DECISION MAKING

Process costing has many advantages for management decision making, including:

1. It monitors production of component parts and sub-assemblies.

2. It provides good inventory management by retaining accurate records of the amount of materials, labor and overhead on an equivalent unit basis.

3. It assists management in the evaluation of the performance of processing departments and product managers.

4. It helps to determine the most efficient or least costly alternative production method or process. The information may assist management in deciding to invest in a new plant, new machinery, or repair existing machinery.

5. It reveals to management the number of unfinished period-end units so management can anticipate how quickly those units will be completed in the next period. While process costing requires less paperwork and detail, it has certain drawbacks. Under a process costing system, management is unable to explicitly identify actual costs with individual items. Therefore, if a particular product incurs any unusual costs, such as excessive spoilage or rework, it's costs would be averaged with the other products' costs. Averaging simplifies the process but makes cost less specific and less informative.

SPOILABLE IN GENERAL

Most production processes generate some bad units, along with the good ones, as an unavoidable result of the most economical combination of the factors of production. Although it may be technically possible to eliminate spoilage altogether in many instances, it may be uneconomical to do so because the costs of lowering spoilage rates are greater than the costs of the present spoilage. Thus, beer bottles sometimes explode, defective castings inevitably appear, and impure as well as pure chemicals and food arise. The problem of spoilage is important from many aspects, the most important being that of managerial planning and control. Managers must first select the most economical production method or process. Then they must see that spoilage is controlled within chosen predetermined limits, so that excessive spoilage does not occur.

Normal Spoilage

Working within the selected set of production conditions, management must establish the rate of spoilage that is to be regarded as normal. Normal spoilage is what arises under efficient operating conditions, it is an inherent result of the particular process and is thus uncontrollable in the short run. Costs of normal spoilage are typically viewed as a part of the costs of good production, because the attaining of good units necessitates the simultaneous appearance of spoiled units. In other words, normal spoilage is planned spoilage, in the sense that the choice of a given combination of factors of production entails a spoilage rate that management is willing to accept.

Abnormal Spoilage

Abnormal spoilage is spoilage that is not expected to arise under efficient operating conditions, it is not an inherent part of the selected production process. Most of this spoilage is usually regarded as controllable, in the sense that the first-line supervisor can exert influence over inefficiency. Such causes as machinery breakdowns, accidents, and inferior materials are typically regarded as being subject to some manager's control and is written off directly as losses for the period in which it is detected. For the most informative feedback, the Loss from Abnormal Spoilage account should appear on a detailed income statement as a separate line item and not be buried as an indistinguishable part of the cost of goods manufactured.

Process-Cost Accounting Procedures and Spoilage

Although this discussion of process costing will emphasize accounting for spoilage, the ideas here are equally applicable to waste (shrinkage, evaporation, or lost units). Again we must distinguish between control and product costing. For control, most companies use some version of estimated or standard. This section emphasizes product costing in normal process-costing systems.

Distinguish Between Normal and Abnormal Spoilage

As a general rule, accumulate the costs of spoilage separately. Then allocate normal spoilage costs to Finished Goods or Work in Process, depending on where in the production cycle the spoilage is assumed to have taken place. Spoilage is typically assumed to occur at the stage of completion where inspection takes place, because spoilage is not detected until this point. Normal spoilage need not be allocated to units that have failed to reach this point in the production process, because the spoiled units are related solely to the units that have passed the inspection point.

Many writers on process costing advocate ignoring the computation of equivalent units for spoilage, shrinkage, or waste. The reason cited in favor of this shortcut technique is that it automatically spreads normal-spoilage costs over good units through the use of higher equivalent unit costs. However, the results of this shortcut are inaccurate unless (a)no work-in-process inventories exist, or (b) material, conversion, and spoilage costs are all incurred uniformly throughout the production cycle. To illustrate, assume that a department has no beginning inventory. It starts 1,000 units; 500 are completed, 400 are in process, half-completed, and 100 are spoiled. The 100 units represent normal spoilage. Spoilage is detected upon completion. Material costs are $1,800 and conversion costs are $1,400. All material is introduced at the start of the process.

The solution shows that ignoring spoilage lowers total equivalent units, when the latter is divided into the production costs, a higher unit cost results. The effective result is to load higher unit costs on work in process that has not reached the inspection point. At the same time, total charges to completed units are too low. Therefore, ending work in process contains costs of spoilage ($130 in this example) that do not pertain to such units and that should properly be charged to completed goods. Furthermore, ending work in process that has not reached inspection undoubtedly contains some units that will not be properly recognized as spoilage ($130) but should instead be charged to goods later as they are completed. In effect, work in process is being doubly charged, because it is being charged with spoilage both now and also later when inspection occurs.

B COMPANY
PRODUCTION-COST REPORT
WEIGHTED AVERAGE METHOD

For the Month ended January 31, 20_1

	(STEP 1) PHYSICAL UNITS	**(STEP 2)** EQUIVALENT UNITS	
FLOW OF PRODUCTION		Materials	Conversion Cost
Work in process, beginning inventory	2,000(80%)*		
Started	8,000		
To account for	10,000		
Abnormal spoilage	580	580	580
Normal spoilage	720	720	720
Good units completed and transferred out	7,200	7,200	7,200
Work in process, ending inventory	1,500*	1,500	1,000
Accounted for	10,000	10,000	9,500
Work in process, ending inventory	$29,600	$15,000	$14,600
Current costs	141,400	61,000	80,400
(STEP 3)			
Total costs to account for	$171,000	$76,000	$95,000
Divide by equivalent units		10,000	9,500
(STEP 4)			
Cost per equivalent unit	$ 7.60	$10.00	$17.60
(STEP 5)			
TOTAL COSTS OF WORK COMPLETED AND IN PROCESS			
Abnormal spoilage(580)	$10,208		580($17.60)
Units completed and transfer out (7,200):			
Costs before adding spoilage	$126,720		7,200($17.60)
Normal spoilage	12,672		720($17.60)
Total cost transfer out	$139,192		

Work in process, ending inventory(1,500):		
Materials	$11,400	1,500($7.60)
Conversion costs	10,000	1,000($10.00)
Total work in process	$21,400	
Total costs account for	$171,000	

* Degree of completion for conversion costs of this department at the dates of the work-in-process inventories. Note that material costs are fully completed at each of these dates, because in this department materials are introduced at the beginning of the process.

COST ALLOCATION: ALLOCATION OF SERVICE DEPARTMENT COSTS TO PRODUCTION DEPARTMENTS

Cost allocation is the process of assigning and reassigning costs that cannot feasibly be directly associated with specific cost objects. Cost allocation is often used for purposes of measuring income and assets for external reporting purposes. Cost allocation is less meaningful for internal purposes because decision making may be more accurate if more or less arbitrary allocations are avoided.

There are two basic types of departments in a manufacturing company: production departments and service departments. A production department (such as assembly or machining) is where the production or conversion occurs. A service department (such as engineering or maintenance) provides support to production departments. Before departmental factory overhead rates are developed for product costing, the costs of a service department should be allocated to the appropriate production departments (as part of factory overhead).

Basis of Assigning Service Department Costs

Some service department costs are direct. Examples are the salaries of the workers in the department. Other service department costs are indirect--that is, they are incurred jointly with some other department. An example is depreciation of building. These indirect costs must be allocated on some arbitrary basis. The problem is selecting appropriate bases for assigning the indirect costs of service departments to other departments. Service department costs should be allocated on a basis that reflects the type of activity in which the service department is engaged. The ideal basis should be logical, have a high cause-and-effect relationship between the service provided and the costs of providing it, and be easy to implement. The basis selected may be supported by physical observation, by correlation analysis, or logical analysis of the relationships between the departments. A list of some service departments and possible bases for allocation is given below.

Service Departments	*Allocation Basis*
Supplies	Number of requisitions
Power	Kilowatt-hours used

Buildings and grounds	Number of square or cubic feet
Maintenance and repairs	Machine hours or number of calls
Personnel	Number of employees
Cafeteria	Number of employees
Purchasing	Number of orders

PROCEDURE FOR SERVICE DEPARTMENT COST ALLOCATION

Once the service department costs are known, the next step is to allocate the service department costs to the production departments. This may be accomplished by one of the following procedures:

(1) Direct method
(2) Step method
(3) Reciprocal method

Direct Method

Direct method is a method of allocating the costs of each service department directly to production departments, with no intermediate allocation to other service departments. That is, no consideration is given to services performed by one service department for another. This is perhaps the most widely used method because of its simplicity and ease of use.

EXAMPLE 3

Assume the following data:

	Service Departments		*Production Departments*	
	General Plant(GP)	*Engineering (E)*	*A Machining*	*B Assembly*
Overhead costs before allocation	$20,000	$10,000	$30,000	$40,000
Direct labor hours by General Plant(GP)	15,000	20,000	60,000	40,000
Engineering hours by Engineering(E)	5,000	4,000	50,000	30,000

Using the direct method yields:

	Service Departments		*Production Departments*	
	GP	*E*	*A*	*B*
Overhead costs	$20,000	$10,000	$30,000	$40,000

Reallocation:

GP(60%, 40%)*	($20,000)		12,000	8,000
E(5/8, 3/8)#		($10,000)	6,250	3,750
			$48,250	$51,750

*Base is (60,000+40,000=100,000); 60,000/100,000=.6; 40,000/100,000=.4
#Base is (50,000+30,000=80,000); 50,000/80,000=5/8; 30,000/80,000=3/8

Step Method

This is a method of allocating services rendered by service departments to other service departments using a sequence of allocation; also called the step-down method, and the sequential method. The sequence normally begins with the department that renders service to the greatest number of other service departments; the sequence continues in step-by-step fashion and ends with the allocation of costs of service departments that provide the least amount of service. After a given service department's costs have once been allocated, it will not receive any charges from the other service departments.

Using the same data, the step allocation method yields:

	Service Departments		Production Departments	
	GP	E	A	B
Overhead costs	$20,000	$10,000	$30,000	$40,000
Reallocation:				
GP(1/6, 1/2, 1/3)*	($20,000)	3,333	10,000	6,667
E(5/8, 3/8)#	($13,333)		8,333	5,000
			$48,333	$51,667

*Base is (20,000+60,000+40,000=120,000); 20,000/120,000=1/6; 60,000/20,000=1/2; 40,000/120,000=1/3
#Base is (50,000+30,000=80,000); 50,000/80,000=5/8; 30,000/80,000=3/8

Reciprocal Method

Reciprocal allocation method, also known as the *reciprocal service method*, *the matrix method*, and the *simultaneous allocation method*, is a method of allocating service department costs to production departments, where reciprocal services are allowed between service departments. The method sets up simultaneous equations to determine the allocable cost of each service department.

Using the same data, we set up the following equations:

$$GP = \$20,000 + 50/85\ E$$
$$E = \$10,000 + 1/6\ GP$$

Substituting E from the second equation into the first:

$$GP = \$20,000 + 5/85\ (\$10,000 + 1/6\ GP)$$

Solving for GP gives GP = \$28,695. Substituting GP=\$28,695 into the second equation and solving for E gives E= \$14,782.

Using these solved values, the reciprocal method yields:

	Service Departments		*Production Departments*	
	GP	*E*	*A*	*B*
Overhead costs	\$20,000	\$10,000	\$30,000	\$40,000
Reallocation:				
GP(1/6, 1/2, 1/3)	(\$28,695)	4,782	14,348	9,565
E(50/85, 30/85, 5/85)	8,695	(\$14,782)	5,217	870
	0	0	\$49,565	\$50,435

JOINT PRODUCT AND BYPRODUCT COSTS

When two or more types of products result from a single production process, the outputs are referred to as either joint products or byproducts, depending on their relative importance. Joint products are those that have a relatively significant sales value, while byproducts are those whose sales value is relatively minor in comparison with the value of the main, or joint, products.

Joint costs are the cost of inputs that are required for the joint products as a group. They cannot be identified directly with any of the joint products that emerge from the process. An example of a joint cost is the price paid for a steer by a packing house. Various joint products such as different cuts of meat, hides, glue, and fertilizer emerge. (The last two might be classified as byproducts if their value is relatively small.) It is impossible to tell how much of the cost of each steer pertains to T-bone steaks, hamburger, hides, and so forth. Any assignment of the joint cost to the joint products is arbitrary. The point in the production process at which joint products are separated is the split-off point. After that point each type of product can be separately identified and is independent of the others. Separate decisions can be made as to whether to sell the joint products as they are or to process them further before sale.

Accounting for Joint Products

Three different bases of allocating joint costs to products have sometimes been advocated:

(1) The physical unit basis.
(2) The sales value basis.
(3) The relative sales value (net realizable value) basis.

The physical unit basis of allocating joint cost to the resulting joint products assigns an equal share of the joint cost to the outputs on the basis of some physical measure, such as gallons or pounds, contained in each output.

Assume that two chemical products result from a single production process. During a given period, the total input costs of the joint process amounted to $400,000. The output consisted of 200,000 gallons of Product A and 300,000 gallons of Product B.

The total cost allocated to each type of product can be computed as follows:

$$\frac{\text{Quantity of each product}}{\text{Total output quantity}} \times \text{ Joint cost} = \text{Total cost allocated to each joint product}$$

Thus:

$$\text{Product A total cost} = \frac{200{,}000 \text{ gallons}}{500{,}000 \text{ gallons}} \times \$400{,}000 = \$160{,}000$$

$$\text{Product B total cost} = \frac{300{,}000 \text{ gallons}}{500{,}000 \text{ gallons}} \times \$400{,}000 = \$240{,}000$$

The relative sales-value (net realizable value) method is the most frequently used method to allocate joint costs to joint products. It allocates joint costs based upon the products' proportion of total sales revenue. For joint products salable at the split-off point, the relative sales value is the selling price at split-off. However, if further processing is needed, the relative sales value is approximated by subtracting the additional anticipated processing costs from the final sales value to arrive at the estimated net realizable value.

METHODS OF ACCOUNTING FOR BYPRODUCT COSTS

Byproducts were already defined as products resulting from a single production process but whose sales value is relatively minor in comparison with the value of the main, or joint, products. Because the relative value of the byproducts is not very important, it is usually considered undesirable to use a refined accounting method in dealing with byproduct costs. Thus the methods used to allocate joint costs to joint products (physical unit basis, sales value basis, and net realizable value basis) are not used in accounting for byproducts because the value of the resulting information would not be worth the cost of obtaining it.

Several different methods of accounting for byproducts are in use. Their main difference lies in whether or not they assign an inventoriable cost to byproducts in the period in which they are produced.

There are two methods that do not assign a cost to byproduct inventory in the period of production:

(1) Revenue from byproduct sales is treated as sales revenue, or miscellaneous revenue, in the period in which the byproduct is sold.

(2) Revenue from byproduct sales is treated as a deduction from cost of goods sold in the period in which the byproduct is sold.

CHAPTER SUMMARY

Process costing makes no attempt to cost any specific lot in process. All costs, direct and indirect, are accumulated by departments for periods of time; and an average cost for the period is computed. It is used by manufacturers whose products are produced on a continuous basis with units receiving equal attention in each processing center.

The chapter discussed the five steps in process costing determination: the check of a physical flow, computation of equivalent units, summary of costs, calculation of the unit costs, and calculation of the cost of goods completed and the ending work-in-process. Distinction must be made between the normal and the abnormal losses in unit cost calculations.

Before departmental factory overhead rates are developed for product costing, the costs of a service department should be allocated to the appropriate production departments (as part of factory overhead). Three methods were discussed.

Methods of accounting for joint and byproduct costs were also illustrated. Choice of the system, job order or process, depends on the nature of the manufacturing operations and the desired information.

CHAPTER 15
TOTAL QUALITY MANAGEMENT AND QUALITY COSTS

In order to be globally competitive in today's world-class manufacturing environment, firms place an increased emphasis on quality and productivity. Total quality management (TQM) is an effort in this direction. Simply put, it is a system for creating competitive advantage by focusing the organization on what is important to the customer. Total quality management can be broken down into: "Total": that is the whole organization is involved and understands that customer satisfaction is everyone's job. "Quality": the extent to which products and services satisfy the requirements of internal and external customers. "Management": the leadership, infrastructure and resources that support employees as they meet the needs of those customers.

After studying the material in this chapter, you will be able to

- Define quality and explain how quality of design and quality of conformance differ.

- Describe TQM and explain its relationship to quality costs.

- Identify and discuss the four types of quality costs.

- Explain the difference between the traditional view of acceptable quality level and the zero-defect view.

- Prepare four different types of quality performance reports.

QUALITY DEFINED

A quality product or service is one that conforms to customer satisfactions. Generally, there are two types of product quality - quality of design and quality of conformance. Quality of design measures the functionality of a product or service. It is the decision of a designer to include or exclude certain features from a product. It is really measured by the customer through appearance, operation, and reliability. Quality of performance measures how closely products and services match the intent of the design. This traditionally has been the focus of quality management program. In this regard, quality refers to doing it right the first time.

TOTAL QUALITY MANAGEMENT

Total quality management (TQM) is supported by two key beliefs that quality is what the customer says it is, and that it must be thoroughly integrated into the very fabric of the organization, including its basic strategies, culture, and management systems. It is essentially an endless quest for perfect quality. It is a *zero-defects* approach. It views the optimal level of quality costs as the level where zero defects are produced. This approach to quality is opposed to the traditional belief, called *acceptable quality level (AQL*), which allows a predetermined level of defective units to be produced and sold. AQL is the level where the number of defects allowed minimizes total quality costs. The rationale behind the traditional view is that there is a tradeoff between prevention and appraisal costs and failure costs. As you increase prevention and appraisal costs, you expect to see failure costs decrease. Figure 1 graphically illustrates the relationship between these two cost components under two different views.

Studies indicate that the total cost of poor quality, or the cost of not doing the right things right the first time, is 20 percent of gross sales for manufacturing companies and 30 percent for service industries. If U.S. production of goods and services is estimated at $6 trillion, then the potential for savings from improved quality is a staggering almost $1.5 trillion that can be saved or redirected for better use. Quality experts maintain that the optimal quality level should be about 2.5% of sales. The accounting department should be a major force in the firm that keep track of and report quality costs.

Principles of TQM

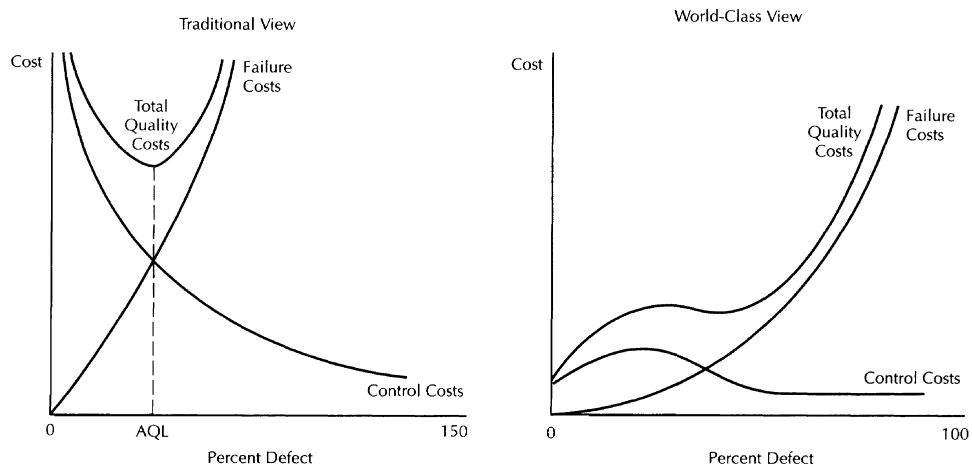
Making a product right the first time is one of the principal objectives of TQM. Implementing a successful TQM program will in fact reduce costs rather than increase them. There is no question that better quality will result in better productivity. This is based on the principle that when less time is spent on rework or repair, more time is available for manufacturing, which will increase productivity.

When an organization maintains accurate records of its cost of quality, TQM will demonstrate that effective quality assurance geared towards prevention versus correction will pay for itself. A good example of this is the situation where it is possible to eliminate 100% inspection with a good statistical process control (SPC) program. Elimination of high reject rates results in fewer products being repaired, reworked or scrapped with the obvious reductions in cost.

Tying the cost of quality to TQM is necessary in order to motivate management who is cost motivated in both industry and government. In a TQM environment, management will start utilizing the cost data to measure the success of the program. The corporate financial planner can determine that overall product costs are being reduced by the TQM program. Given this success in the prevention of defects, the following failure costs will be reduced or eliminated:

FIGURE 1

TRADITIONAL VIEW VERSUS WORLD-CLASS VIEW



1. Rework or repair
2. Inspection of rework
3. Testing of rework
4. Warranty costs
5. Returned material
6. Discounts, adjustments and allowances

It is obvious that the cost of prevention in TQM is minor when taken against the above listed failure costs.

A checklist of TQM features are as follows:
A systematic way to improve products and services
A structured approach in identifying and solving problems
Long term
Conveyed by management's actions
Supported by statistical quality control
Practiced by everyone

ELEMENTS OF TQM

The major elements of TQM are straight-forward and embrace a common-sense approach to management. However, each of the individual elements must be integrated into a structured whole to succeed.

The elements are as follows:

1. A Focus on the Customer

Every functional unit has a customer, whether it be an external consumer or an internal unit. TQM advocates that managers and employees become so customer-focused that they continually find new ways to meet or exceed customers' expectations. We must accept that quality is defined by the customer. Meeting the customer's needs and expectations is the strategic goal of TQM.

2. A Long Term Commitment

Experience in the U.S. and abroad shows that substantial gains come only after management makes a long-term commitment, usually five years or more, in improving quality. Customer-focus must be constantly renewed to keep that goal foremost.

3. Top Management Support and Direction

Top management must be the driving force behind TQM. Senior managers must exhibit personal support by using quality improvement concepts in their management style, incorporating quality in their strategic planning process, and providing financial and staff support.

4. Employee Involvement

Full employee participation is also an integral part of the process. Each employee must be a partner in achieving quality goals. Teamwork involves managers, supervisors, and employees in improving service delivery, solving systemic problems, and correcting errors in all parts of work processes.

5. Effective and Renewed Communications

The power of internal communication, both vertical and horizontal, is central to employee involvement. Regular and meaningful communication from all levels must occur. This will allow an agency to adjust its ways of operating and reinforce the commitment of TQM at the same time.

6. Reliance on Standards and Measures

Measurement is the springboard to involvement, allowing the organization to initiate corrective action, set priorities and evaluate progress. Standards and measures should reflect customer requirements and changes that need to be introduced in the internal business of providing those requirements. The emphasis is on "doing the right thing right the first time".

7. Commitment to Training

Training is absolutely vital to the success of TQM. The process usually begins with awareness training for teams of top level managers. This is followed by courses for teams of mid-level managers, and finally by courses for non-managers. Awareness training is followed by an identification of areas of concentration, or of functional areas where TQM will first be introduced. Implementing TQM requires additional skills training, which is also conducted in teams.

8. Importance of Rewards and Recognition

Most companies practicing TQM have given wide latitude to managers in issuing rewards and recognition. Here, a common theme is that individual financial rewards are not as appropriate as awards to groups or team members, since most successes are group achievements.

COST OF QUALITY

Market shares of many U.S. firms have eroded because foreign firms have been able to sell higher-quality products at lower prices. In order to be competitive, U.S. firms have placed an increased emphasis
on quality and productivity in order to:

1. produce savings such as reducing rework costs
2. improve product quality

Studies indicate that costs of quality for American companies are typically 20-30% of sales. Quality experts maintain that the optimal quality level should be about 2.5% of sales.

Costs of quality are costs that occur because poor quality may exist or actually does exist. More specifically, quality costs are the total of the costs incurred by (1) investing in the prevention of nonconformances to requirements; (2) appraising a product or service for conformance to requirements; and (3) failure to meet requirements.

Quality costs are classified into three broad categories (See Figure 1): prevention, appraisal, and failure costs. *Prevention costs* are those incurred to prevent defects. Amounts spent on quality training programs, researching customer needs, quality circles, and improved production equipment are considered in prevention costs. Expenditures made for prevention will minimize the costs that will be incurred for appraisal and failure. *Appraisal costs* are costs incurred for monitoring or inspection; these costs compensate for mistakes not eliminated through prevention. *Failure costs* may be internal (such as scrap and rework costs and reinspection) or external (such as product returns due to quality problems, warranty costs, lost sales due to poor product performance, and complaint department costs). Figure 2 summarizes these quality cost components.

WHAT IS QUALITY?

A quality product is a product that conforms to customer expectations.

Generally, there are two types of product quality.

1. Quality of design refers to quality differences of products that serve the same function but have different design specifications, such as the type and quality of materials used in the product. Usually higher design quality results in higher manufacturing costs and higher selling prices. For example, 14 karat gold jewelry has higher design value than the same jewelry that is gold plated.

2. Quality of conformance is a measure of how a product meets its design specifications. Is the product manufactured as the design specifies?

When quality experts refer to improving quality, they are referring to reducing the incidence of nonconformance.

Quality refers to doing it right the first time.

TWO DIFFERENT VIEWS CONCERNING OPTIMAL QUALITY COSTS

There are two views concerning optimal quality costs:

1. Traditional view that uses an acceptable quality level
2. World-class view that uses total quality control

Optimal Distribution of Quality Costs: Traditional View

The traditional approach uses an acceptable quality level (AQL) that permits a predetermined level of defective units to be produced and sold. AQL is the level where the number of defects allowed minimizes total quality costs. The reasoning of the traditional approach is that there is a tradeoff between failure costs and prevention and appraisal costs. As prevention and appraisal costs increase, internal and external failure costs are expected to decrease. As long as the decrease in failure costs is greater than the corresponding increase in prevention and failure costs, a company should continue increasing its efforts to prevent or detect defective units.

Optimal Distribution of Quality Costs: World-Class View

The world-class view uses total quality control and views the optimal level of quality costs as the level where zero defects are produced. The zero-defects approach uses a quality performance standard that requires:

1. Products to be produced according to specifications
2. Services to be provided according to requirements

Zero defects reflects a total quality control philosophy used in JIT manufacturing.

QUALITY COST AND PERFORMANCE REPORTS

The first step in a quality cost reporting system is to prepare a detailed listing of actual quality costs by category. Furthermore, each category of quality costs is expressed as a percentage of sales. This serves two purposes:

1. Permits managers to assess the financial impact of quality costs
2. Reveals the relative emphasis placed on each category

FIGURE 2
QUALITY COSTS - GENERAL DESCRIPTION

PREVENTION COSTS
The costs of all activities specifically designed to prevent poor quality in products or services. Examples are the costs of new product review, quality planning, supplier capability surveys, process capability evaluations, quality improvement team meetings, quality improvement projects, and quality education and training.

APPRAISAL COSTS
The costs associated with measuring, evaluating or auditing products or services to assure conformance to quality standards and performance requirements. These include the costs of incoming and source inspection/test of purchased material, in process and final inspection/test, product, process, or service audits, calibration of measuring and test equipment, and the costs of associated supplies and materials.

FAILURE COSTS
The costs resulting from products or services not conforming to requirements or customer/user needs. Failure costs are divided into internal and external failure cost categories.

INTERNAL FAILURE COSTS
Failure costs occurring prior to delivery or shipment of the product, or the furnishing of a service, to the customer. Examples are the costs of scrap, rework, reinspection, retesting, material review, and down grading.

EXTERNAL FAILURE COSTS
Failure costs occurring after delivery or shipment of the product, and during or after furnishing of a service, to the customer. Examples are the costs of processing customer complaints, customer returns, warranty claims, and product recalls.

TOTAL QUALITY COSTS
The sum of the above costs. It represents the difference between the actual cost of a product or service, and what the reduced cost would be if there was no possibility of substandard service, failure of products, or defects in their manufacture.

Quality cost reports can be used to point out the strengths and weaknesses of a quality system. Improvement teams can use them to describe the monetary benefits and ramifications of proposed changes. Return-on-investment (ROI) models and other financial analyses can be constructed directly from quality cost data to justify proposals to management. In practice, quality costs can define activities of quality program and quality improvement efforts in a language that management can understand and act on - dollars.

The negative effect on profits, resulting from product or service of less than acceptable quality or from ineffective quality management, is almost always dynamic. Once started, it continues to mushroom until ultimately the company finds itself in serious financial difficulty due to the two-pronged impact of an unheeded increase in quality costs coupled with a declining performance image. Management that clearly understands this understands the economics of quality.

In the quality cost report, quality costs are grouped into one of four categories:

1. prevention costs
2. appraisal costs
3. internal failure costs
4. external failure costs

In addition, each category of quality costs is expressed as a percentage of sales. There are four types of performance reports to measure a company's quality improvement. They are:

1. *Interim quality performance report* It measures the progress achieved within the period relative to the planned level of progress for the period (see Figure 3).

2. *One-year quality trend report* It compares the current year's quality cost ratio with the previous year's ratio.(see Figure 4). More specifically, it compares (1) the current year's variable quality cost ratio with the previous year's variable quality cost ratio, and the current year's actual fixed quality costs with the previous year's actual fixed quality costs (see Figure 4).

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3. *Multiple-period quality report* It shows the overall trend of quality costs by category since the inception of the quality enhancement program (see Figure 5).

4. *Long-range quality performance report* It compares the current year's actual quality costs with the firm's intended long-range quality goal (see Figure 6).

ACTIVITY – BASED MANAGEMENT AND OPTIMAL QUALITY

Activity-based management supports the zero-defect view of quality costs. Activity-based management classifies activities as: (1) value-added activities and (2) nonvalue-added activities.

- Quality-related activities (internal and external failure activities, prevention activities, and appraisal activities) can be classified as value-added and nonvalue-added.
- Internal and external failure activities and their associated costs are nonvalue-added and should be eliminated.
- Prevention activities that are performed efficiently are value-added. (Costs caused by inefficiency in prevention activities are nonvalue-added costs.)
- Appraisal activities may be value-added or nonvalue-added depending upon the activity. For example, quality audits may serve a value-added objective.

Once the quality-related activities are identified for each category, resource drivers can be used to improve cost assignments to individual activities. Root or process drivers can also be identified and used to help managers understand what is causing the cost of the activities.

Using Quality Cost Information

The principal objective of reporting quality costs is to improve and facilitate managerial planning, control, and decision making.

Potential uses of quality cost information include:

1. Quality program implementation decisions
2. Evaluation of the effectiveness of quality programs
3. Strategic pricing decisions (For example, improved reporting of quality costs might be used by managers to target specific quality costs for reductions. A reduction in quality costs might enable a firm to reduce its selling price, improve its competitive position, and increase market share.)
4. Inclusion of quality costs in cost-volume-profit analysis (For example, overlooking quality cost savings results in a higher breakeven and possible rejection of a profitable project.)

The control process involves comparing actual performance with quality standards. This comparison provides feedback that can be used to take corrective action, if necessary.

CHAPTER SUMMARY

In today's tough competition, TQM is "the minimum requirement for staying in the game." Comparing total quality to the current hot managerial idea -- reengineering, both aim to increase productivity by rethinking processes. Reengineering may be more likely to come up with bold solutions because it starts with the question --"Should we still be doing this at all?" rather than TQM's "How can we do this cheaper, faster and better?"

In the long run, quality can only be achieved by involving the total organization in continuous improvement. TQM requires changes in how we lead, what we communicate, what is rewarded, how decisions are made, as well as how accurately quality costs are accounted for and reported.

FIGURE 3
ALLISON PRODUCTS
QUALITY COST REPORT
FOR THE YEAR ENDED MARCH 31, 20X2

	Quality Costs	*Percentage of Sale(a)*	
Prevention costs:			
Quality training	$30,000		
Reliability engineering	79,000	$109,000	3.73%
Appraisal costs:			
Materials inspection	$19,000		
Product acceptance	10,000		
Process acceptance	35,000	$64,000	2.19%
Internal failure costs:			
Scrap	$40,000		
Rework	34,000	$74,000	2.53%
External failure costs:			
Customer complaints	$24,000		
Warranty	24,000		
Repair	15,000	$63,000	2.16%
Total quality costs		$310,000	10.62% (b)

(a) Actual sales of $2,920,000
(b) $310,000/$2,920,000 = 10.62 percent. Difference is rounding error.

FIGURE 4
ALLISON PRODUCTS
INTERIM STANDARD
PERFORMANCE REPORT
FOR THE YEAR ENDED MARCH
31, 20X2

	Actual Costs	*Budgeted Costs(a)*	*Variance*
Prevention costs:			
Quality training	$30,000	$30,000	$0
Reliability engineering	79,000	80,000	1,000 F
Total prevention	$109,000	$110,000	$1,000 F
Appraisal costs:			
Materials inspection	$19,000	$28,000	$9,000 F
Product acceptance	10,000	15,000	5,000 F
Process acceptance	35,000	35,000	0
Total appraisal	$64,000	$78,000	$14,000 F
Internal failure costs:			
Scrap	$40,000	$44,000	$4,000 F
Rework	34,000	36,500	2,500 F
Total internal failure	$74,000	$80,500	$6,500 F
External failure costs:			
Fixed:			
Customer complaints	$24,000	$25,000	$1,000
Variable:			
Warranty	24,000	20,000	(4,000) U
Repair	15,000	17,500	2,500 F
Total external failure	$63,000	$62,500	($500) U
Total quality costs	$310,000	$331,000	$21,000 F
Percentage of actual sales	10.62%	11.34%	0.72% F

(a) Based on actual sales
(b) Actual sales of $2,920,000

FIGURE 5
ALLISON PRODUCTS
QUALITY COST, ONE-YEAR TREND
FOR THE YEAR ENDED MARCH 31, 20X2

	Actual Costs 20x2(a)	*Budgeted Costs 20x1*	*Variance*
Prevention costs:			
Quality training	$30,000	$36,000	$6,000 F
Reliability engineering	79,000	120,000	41,000 F
Total prevention	$109,000	$156,000	$47,000 F
Appraisal costs:			
Materials inspection	$19,000	$33,600	$14,600 F
Product acceptance	10,000	16,800	6,800 F
Process acceptance	35,000	39,200	4,200 F
Total appraisal	$64,000	$89,600	$25,600 F
Internal failure costs:			
Scrap	$40,000	$48,000	$8,000 F
Rework	34,000	40,000	6,000 F
Total internal failure	$74,000	$88,000	$14,000 F
External failure costs:			
Fixed:			
Customer complaints	$24,000	$33,000	$9,000 F
Variable:			
Warranty	24,000	23,000	(1,000) U
Repair	15,000	16,400	1,400 F
Total external failure	$63,000	$72,400	$9,400 F
Total quality costs	$310,000	$406,000	$96,000 F
Percentage of actual sales	10.62%	13.90%	3.29% F
(a) Based on actual sales=	$2,920,000		

FIGURE 6
ALLISON PRODUCTS
LONG-RANGE PERFORMANCE REPORT
FOR THE YEAR ENDED MARCH 31, 20X2

	Actual Costs	*Target Costs(a)*	*Variance*
Prevention costs:			
Quality training	$30,000	$14,000	($16,000) U
Reliability engineering	79,000	39,000	(40,000) U
Total prevention	$109,000	$53,000	($56,000) U
Appraisal costs:			
Materials inspection	$19,000	$7,900	($11,100) U
Product acceptance	10,000	0	(10,000) U
Process acceptance	35,000	12,000	(23,000) U
Total appraisal	$64,000	$19,900	($44,100) U
Internal failure costs:			
Scrap	$40,000	$0	($40,000) U
Rework	34,000	0	(34,000) U
Total internal failure	$74,000	$0	($74,000) U
External failure costs:			
Fixed:			
Customer complaints	$24,000	$0	($24,000) U
Variable:			
Warranty	24,000	0	(24,000) U
Repair	15,000	0	(15,000) U
Total external failure	$63,000	$0	($63,000) U
Total quality costs	$310,000	$72,900	($237,100) U
Percentage of actual sales	10.62%	2.50%	-8.12% U

(a) Based on actual sales of $2,920,000 These costs are value-added costs.

CHAPTER 16
INVENTORY MANAGEMENT AND JUST-IN-TIME

One of the most common problems facing managerial accountants is that of inventory planning. This is understandable since inventory usually represents a sizable portion of a firm's total assets and, more specifically, on the average, more than 30% of total current assets in U.S. industry. Excessive money tied up in inventory is a drag on profitability.

After studying the material in this chapter, you will be able to

- Discuss the objectives of inventory management.
- Describe the basic economic order quantity (EOQ) model and its assumptions and solve typical problems.
- Explain the quantity discount model and solve typical problems.
- Explain reorder point models and solve typical problems.
- Compare JIT with traditional manufacturing.
- List the benefits of JIT.
- State the impacts of JIT on cost accounting and cost management.
- Demonstrate how JIT manufacturing improves product-costing accuracy.
- Cite some successful applications of JIT in U.S. manufacturing firms.

ECONOMIC ORDER POINT (EOQ) AND REORDER POINT

The purpose of inventory planning is to develop policies which will achieve an optimal investment in inventory. This objective is achieved by determining the optimal level of inventory necessary to minimize inventory related costs.

Inventory related costs fall into three categories:

(1*) Ordering costs*, which includes all costs associated with preparing a purchase order.

(2) *Carrying (holding) costs*, which include storage costs for inventory items plus the cost of money tied up in inventory.

(3) *Shortage (stockout) costs*, which include those costs incurred when an item is out of stock. These include the lost contribution margin on sales plus lost customer goodwill.

There are many inventory planning models available which try to answer basically the following two
questions:

(1) How much to order?
(2) When to order?

They include the so-called economic order quantity (EOQ) model, the reorder point, and the determination of safety stock.

Economic Order Quantity

The economic order quantity (EOQ) determines the order quantity that results in the lowest sum of carrying and ordering costs. The EOQ is computed as:

$$\text{EOQ} = \sqrt{\frac{2DO}{C}}$$

where C = carrying cost per unit, O = ordering cost per order, D = annual demand (requirements) in units.

If the carrying cost is expressed as a percentage of average inventory value (say, 12 percent per year to hold inventory), then the denominator value in the EOQ formula would be 12 percent times the
price of an item.

EXAMPLE 1

Assume the Los Alamitos Store buys sets of steel at $40 per set from an outside vendor. It will sell 6,400 sets evenly throughout the year.

The store desires a 16 percent return on its inventory investment since the 16 percent represents the interest charge on the borrowed money. In addition, rent, taxes, etc. for each set in inventory is $1.60 per year. The ordering cost is $100 per order.

Then the carrying cost per set is 16%($40) + $1.60 = $8.00 per year.
Therefore,

$$EOQ = \sqrt{\frac{2(6{,}400)(\$100)}{\$8.00}} = \sqrt{160{,}000} = 400 \text{ sets}$$

Total number of orders per year = D/EOQ =6,400/400 = 16 orders

Total inventory costs = Carrying cost + Ordering cost

= C x (EOQ/2) + O (D/EOQ)

= ($8.00)(400/2) + ($100)(6,400/400)

= $1,600 + $1,600 = $3,200

Based on these calculations, the Los Alamitos Store's inventory policy should be the following:

(1) The store should order 400 sets of steel each time it places an order and order 16 times during a year.

(2) This policy will be most economical and cost the store $3,200 per year.

Reorder Pont

Reorder point (ROP), which answers when to place a new order, requires a knowledge about the lead time, which is the time interval between placing an order and receiving delivery. Reorder point (ROP) can be calculated as follows:

Reorder point = (average usage per unit of lead time x lead time + safety stock

First, multiply average daily (or weekly) usage by the lead time in days (or weeks) yielding the lead time demand. Then add safety stock to this to provide for the variation in lead time demand to determine the reorder point. If average usage and lead time are both certain, no safety stock is necessary and should be dropped from the formula.

EXAMPLE 2

Assume in Example 1, lead time is constant at one week, and that there are 50 working weeks in a year.

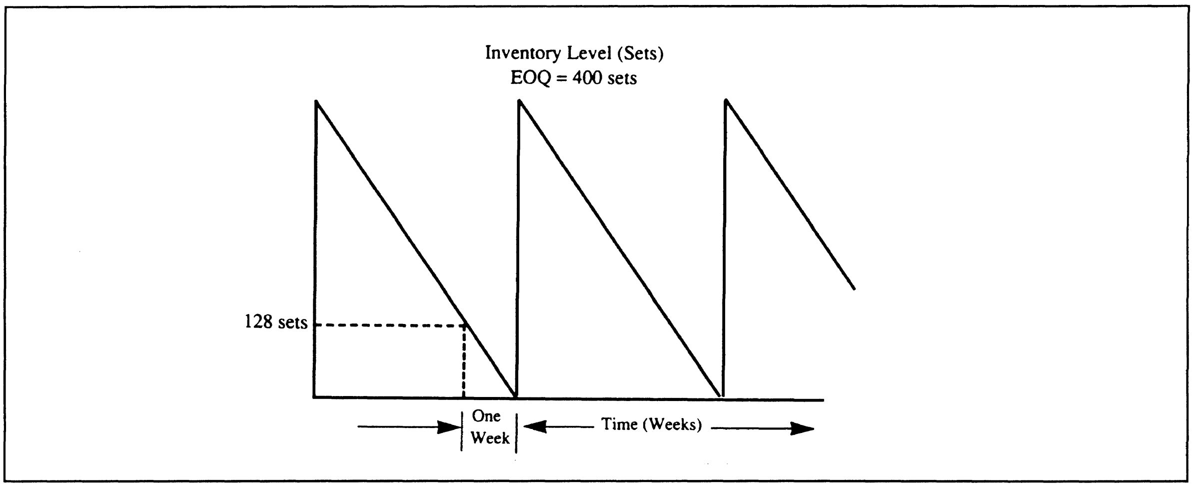
Then the reorder point is 128 sets = (6,400 sets/50 weeks) x 1 week.

Therefore, when the inventory level drops to 128 sets, the new order should be placed. Suppose, however, that the store is faced with variable usage for its steel and requires a safety stock of 150 additional sets to carry. Then the reorder point will be 128 sets plus 150 sets, or 278 sets.

Figure 1 shows this inventory system when the order quantity is 400 sets and the reorder point is 128 sets.

FIGURE 1

BASIC INVENTORY SYSTEM WITH EOQ AND REORDER POINT



Assumptions and Applications

The EOQ model makes some strong assumptions. They are:

1. Demand is fixed and constant throughout the year.
2. Lead time is known with certainty.
3. No quantity discounts are allowed.
4. No shortages are permitted.

The assumptions may be unrealistic. However, the model still proves useful in inventory planning for many firms. In fact, many situations exist where a certain assumption holds or nearly holds.

For example, subcontractors who must supply parts on a regular basis to a primary contractor face a constant demand. Even where demand varies, the assumption of uniform usage is not unrealistic. Demand for automobiles, for example, varies from week to week over a season, but the weekly fluctuations tend to cancel out each other so that seasonal demand can be assumed constant.

EOQ WITH QUANTITY DISCOUNTS

The economic order quantity (EOQ) model does not take into account quantity discounts, which is not realistic in many real world cases. Usually, the more you order, the lower the unit price you pay. Quantity discounts are price reductions for large orders offered to buyers to induce them to buy in large quantities. If quantity discounts are offered, the buyer must weigh the potential benefits of reduced purchase price and fewer orders that will result from buying in large quantities against the increase in carrying costs caused by higher average inventories. Hence, the buyer's goal in this case is to select the order quantity which will minimize total costs, where total cost is the sum of carrying cost, ordering cost, and product cost:

$$\begin{aligned}\text{Total cost} &= \text{Carrying cost} + \text{Ordering cost} + \text{Product cost}\\ &= C \times (Q/2) \quad + \quad O \times (D/Q) \quad + PD\end{aligned}$$

where P = unit price, and Q = order quantity.

A step by step approach in computing economic order quantity with quantity discounts is summarized below.

1. Compute the economic order quantity (EOQ) when price discounts are ignored and the corresponding costs using the new cost formula given above. *Note*: $EOQ = \sqrt{\dfrac{2OD}{C}}$
2. Compute the costs for those quantities greater than the EOQ at which price reductions occur.
3. Select the value of Q which will result in the lowest total cost.

EXAMPLE 3

In Example 1, assume that the Los Alamitos Store was offered the following price discount schedule:

Order quantity (Q)	*Unit price (P)*
1 to 499	$40.00
500 to 999	39.90
1000 or more	39.80

First, the EOQ with no discounts is computed as follows:

$$EOQ = \sqrt{2(6,400)(100/8.00} = \sqrt{160,000} = 400 \text{ sets.}$$

$$\begin{aligned}\text{Total cost} &= \$8.00(400/2) + \$100(6,400/400) + \$40.00(6,400)\\ &= \$1,600 + 1,600 + 256,000 = \$259,200\end{aligned}$$

We see that the value which minimized the sum of the carrying cost and the ordering cost but not the purchase cost was EOQ=400 sets. As can be seen in Figure 2, the further we move from the point 400, the greater will be the sum of the carrying and ordering costs.

Thus, 400 is obviously the only candidate for the minimum total cost value within the first price range. Q=500 is the only candidate within the $39.90 price range and Q=1,000 is the only candidate within the $39.80 price bracket. These three quantities are evaluated in Table 1 and illustrated in Figure 2.

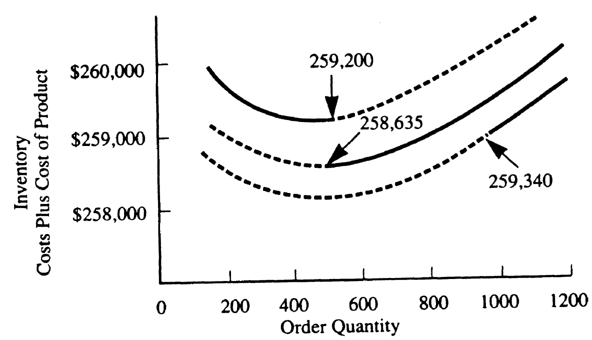
We find that the EOQ with price discounts is 500 sets. Hence, ABC store is justified in going to the first price break but the extra carrying cost of going to the second price break more than outweighs the savings in ordering and in the cost of the product itself.

TABLE 1
ANNUAL COSTS WITH VARYING ORDER QUANTITIES

Order Quantity (Q)	*400*	*500*	*1,000*
Purchase price (P)	$40	$39.90	$39.80
Carrying cost (C x Q/2) $8 x (order quantity/2)	$1,600	$2,000	$4,000
Ordering cost (O x D/Q)			
$100 x (6,400/order quantity)	1,600	1,280	640
Product cost (PD) Units price x 6,400	256,000	255,360	254,720
Total cost	$259,200	$258,640	$259,360

Note that C = $8.00, O = $100, and D = 6,400 for all possible orders.

FIGURE 2
INVENTORY COST AND QUANTITY



Advantages and Disadvantages of Quantity Discounts

Buying in large quantities has some favorable and some unfavorable features. The advantages are lower unit costs, lower ordering costs, fewer stockouts, and lower transportation costs. On the other hand, there are disadvantages such as higher inventory carrying costs, greater capital requirement, and higher probability of obsolescence and deterioration.

DETERMINATION OF SAFETY STOCK

When lead time and demand are not certain, the firm must carry extra units of inventory, called safety stock as protection against possible stockouts. Stockouts can be quite expensive. Lost sales and disgruntled customers are examples of external costs. Idle machine and disrupted production scheduling are examples of internal costs. We will illustrate the probability approach to show how the optimal stock size can be determined in the presence of stockout costs.

EXAMPLE 4

In Examples 1 and 2, suppose that the total usage over a one-week period is expected to be:

Total usage	*Probability*
78	0.2
128	0.4
178	0.2
228	0.1
278	0.1
	1.00

Suppose further that a stockout cost is estimated at $12.00 per set. Recall that the carrying cost is $8.00 per set.

Table 2 shows the computation of safety stock. The computation shows that the total costs are minimized at $1,200, when a safety stock of 150 sets is maintained. Therefore, the reorder point is: 128 sets + 150 sets = 278 sets.

TABLE 2
COMPUTATION OF SAFETY STOCK

Safety stock levels in units	Stockout and probability	Average stockout in units	Average stockout costs	No. of orders	Total annual stockout costs	Carrying costs	Total
0	50 with .2 100 with .1 150 with .1	35*	$420**	16	$6,720***	0	$7,140
50	50 with .1 100 with .1	15	180	16	2,880	400****	3,280
100	50 with .1	5	60	16	960	800	1,760
150	0	0	0	16	0	1,200	1,200

*50(.2) + 100(.1) + 150(.1) = 10 + 10 + 15 = 35 units.
**35 units × $12.00 = $420.
***$420 × 16 times = $6,720.
****50 units × $8.00 = $400.

Just-In-Time Manufacturing and Cost Management

The inventory control problem occurs in almost every type of organization. It exists whenever products are held to meet some expected future demand. In most industries, cost of inventory represents the largest liquid asset under the control of management. Therefore, it is very important to develop a production and inventory planning system that will minimize both purchasing and carrying costs.

Effective purchasing and management of materials is a high priority in most manufacturing firms. Material cost, as a proportion of total product cost, has continued to rise significantly during the last few years and hence is a primary concern of top management.

In recent years, the Japanese have demonstrated the ability to manage their production systems effectively. Much of their success has been attributed to what is known as the *Just-In-Time (JIT)* approach to production and inventory control, which has generated a great deal of interest among practitioners. The "Kanban" system--as they call it-- has been a focal point of interest, with its dramatic impact on the inventory performance and productivity of the Japanese auto industry.

We provide an overview of the Just-In-Time (JIT) approach and its impact on cost management. Some examples of implementation of JIT by U.S. firms are given.

What Is Just-In-Time (JIT)?

JIT is a demand-pull system. Demand for customer output (not plans for using input resources) triggers production. Production activities are "pulled", not "pushed," into action. JIT production, in its purest sense, is buying and producing in very small quantities just in time for use. The basic idea has its roots in Japan's densely populated industrial areas and its lack of resources, both of which have produced frugal personal habits among the Japanese people. The idea was developed into a formal management system by Toyota in order to meet the precise demands of customers for various vehicle models and colors with minimum delivery delays.

As a philosophy, JIT targets inventory as an evil presence that obscures problems that should
be solved, and that by contributing significantly to costs, large inventories keep a company from being as competitive or profitable as it otherwise might be. Practically speaking, JIT has as its principal goal the elimination of waste, and the principal measure of success is how much or how little inventory there is. Virtually anything that achieves this end can be considered a JIT innovation.

Furthermore, the little inventory that exists in a JIT system must be of good quality. This requirement has led to JIT purchasing practices uniquely able to deliver high-quality materials.

JIT systems integrate five functions of the production process--sourcing, storage, transportation, operations, and quality control--into one controlled manufacturing process. In manufacturing, JIT means that a company produces only the quantity needed for delivery to dealers or customers. In purchasing, it means suppliers deliver subassemblies just in time to be assembled into finished goods. In delivery, it requires selecting a transportation mode that will deliver purchased components and materials in small-lot sizes at the loading dock of the manufacturing facilities just in time to support the manufacturing process.

JIT Compared with Traditional Manufacturing

JIT manufacturing is a demand-pull, rather than the traditional "push" approach. The philosophy underlying JIT manufacturing is to produce a product 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. To illustrate the differences between pull and push systems of material control, the example of a fast food restaurant is used:

"At McDonald's, the customer orders a hamburger, the server gets one from the rack, the hamburger maker keeps an eye on the rack and makes new burgers when the number gets too low. The manager orders more ground beef when the maker's inventory gets too low. In effect, the customer' purchase triggers the pull of materials through the system...... In a push system, the caterer estimates how many steaks are likely to be ordered in any given week. He/she reckons how long it takes to broil a steak: he/she can figure out roughly how many meals are needed in a certain week..... "

Reduced Inventories. The primary goal of JIT is to reduce inventories to insignificant or zero levels. In traditional manufacturing, inventories result whenever production exceeds demand. Inventories are needed as a buffer when production does not meet expected demand.

Manufacturing Cells and Multifunction Labor. In traditional 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. JIT replaces this traditional pattern with a pattern of manufacturing cells or work centers. Robots supplement people to do many routine operations.

Manufacturing cells contain machines that are grouped in 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. Thus, labor in a JIT environment is multifunction labor, not specialized labor. Each manufacturing cell is basically a minifactory or a factory within a factory. A comparison of the physical layout of JIT with the traditional system is shown in Figure 3.

Total Quality Control. JIT goes with it a stronger emphasis on quality control. A defective part brings production to a grinding halt. Poor quality simply cannot be tolerated in a stockless manufacturing environment. In other words, JIT cannot be implemented without a commitment to *total quality control (TQC).* TQC is essentially an endless quest for perfect quality. This approach to quality is opposed to the traditional belief, called *acceptable quality level (AQL).* AQL allows defects to occur provided they are within a predetermined level.

Decentralization of Services. JIT requires easy and quick access to support services, which means that centralized service departments must be scaled down and their personnel assigned to work directly to support production. For example, with respect to raw materials, JIT calls for multiple stock points, each one near where the material will be used. There is no need for a central warehouse location.

Suppliers as Outside Partners The most important aspects of the JIT purchasing concept focus on (1) new ways of dealing with suppliers, and (2) a clear-cut recognition of the appropriate purchasing role in developing corporate strategy. Suppliers should be viewed as "outside partners" who can contribute to the long-run welfare of the buying firm rather than as outside adversaries.

Better Cost Management. Cost management differs from cost accounting in that it refers to the management of cost, whether or not the cost has direct impact on inventory or the financial statements. The JIT philosophy simplifies the cost accounting procedure and helps managers manage and control their costs, which will be discussed in detail later in the chapter.

JIT recognizes that with simplification comes better management, better quality, better service, and better cost. Traditional cost accounting systems have a tendency to be very complex, with many transactions and reporting of data. Simplification of this process will transform a cost "accounting" system into a cost "management" system that can be used to support management's needs for better decisions about product design, pricing, marketing, and mix, and to encourage continual operating improvements.

The major differences between JIT manufacturing and traditional manufacturing are summarized in Table 3.

FIGURE 3
PHYSICAL LAYOUT
TRADITIONAL VS. JIT MANUFACTURING

<u>Traditional Manufacturing</u>

Department A	Department B	Department C
<P1 > X X	< P1 > Y Y	< P1 > Z Z
<P2 >	< P2 >	< P2 >

Each product passes through departments which specialize in one process. Departments process multiple products.

JIT Manufacturing

Product 1 (P1)	Product 2 (P2)
Manufacturing Cell 1	Manufacturing Cell 2
Y	Y
<P1 > X Z	<P2 > X Z

Notice that each product passes through its own cell. All machines necessary to process each product are placed within the cell. Each cell is dedicated to the production of one product or one subassembly.
Symbols:

X = Machine A P1 = Product 1
Y = Machine B P2 = Product 2
Z = Machine C

TABLE 3
COMPARISON OF JIT AND TRADITIONAL MANUFACTURING

JIT	*Traditional*
1. Pull system	1. Push system
2. Insignificant or zero inventories	2. Significant inventories
3. Manufacturing cells	3. “Process” structure
4. Multifunction labor	4. Specialized labor
5. Total quality control (TQC)	5. Acceptable quality level (AQL)
6. Decentralized services	6. Centralized services
7. Complex cost accounting	7. Simple cost accounting

Benefits of JIT

The potential benefits of JIT are numerous. First, JIT practice reduces inventory levels, which means lower investments in inventories. Since the system requires only the smallest quantity of materials needed immediately, it reduces the overall inventory level substantially. In many Japanese companies that use the JIT concept, inventory levels have been reduced to the point that makes the annual working capital turnover ratio much higher than that experienced by U.S. counterparts. For instance, Toyota reported inventory turnover ratios of 41 to 63, while comparable U.S. companies reported inventory turnover ratios of 5 to 8.

Second, since purchasing under JIT requires a significantly shorter delivery lead time, lead time reliability is greatly improved. Reduced lead time and increased reliability also contribute to a significant reduction in the safety stock requirements.

Third, reduced lead times and set-up times increase scheduling flexibility. The cumulative lead time, which includes both purchasing and production lead times, is reduced. Thus, the firm schedule within the production planning horizon is reduced. This results in a longer "look-ahead" time that can be used to meet shifts in market demand. The smaller lot size production made possible by reduced set-up time, also adds flexibility.

Fourth, improved quality levels have been reported by many companies. When the order quantity is small, sources of quality problems are quickly identifiable, and can be corrected immediately. In many cases, employee quality consciousness also tends to improve, producing an improvement in quality at the production source.

Fifth, the costs of purchased materials may be reduced through more extensive value analysis and cooperative supplier development activities.

Sixth, other financial benefits reported include:

(1) Lower investments in factory space for inventories and production.
(2) Less obsolescence risk in inventories
(3) Reduction in scrap and rework
(4) Decline in paperwork

(5) Reduction in direct material costs through quantity purchases.

Examples of JIT Implementation in the U.S.

The following are some of the many implementation experiences of JIT in the U.S.:
(1) The Oldsmobile division of General Motors (GM) has implemented a JIT project which permits immediate electronic communication between Oldsmobile and 70 of its principal suppliers who provide 700 to 800 parts representing around 85% of the parts needed for the new GM-20 cars.

(2) PTC Components, a supplier to GM, has assisted GM in its use of stockless production by sending one truck a week to deliver timing chains to several GM's engine plants rather than accumulate a truckload to ship to each plant.

(3) Ford introduced JIT production at its heavy-duty truck plant in Kentucky, which forced Firestone to switch the tire searching point from Mansfield to Dayton, Ohio. By combining computerized ordering and halving inventory, Firestone has been able to reduce its own finished goods inventory. In addition, its production planning is no longer guesswork.

(4) Each day a truck from Harley-Davidson Motor Co. transports 160 motorcycle seats and assorted accessories 800 miles overnight to Harley's assembly plant in York, Pa., as a part of their advanced
"Materials as Needed" (MAN) program--its version of JIT.

(5) The Hoover Company has used JIT techniques in its two plants at North Canton, Ohio, for a number of years for production scheduling and material flow control of 360 different models and 29,000 part numbers.

(6) Some plants of Du Pont used JIT and had an inventory savings of 30 cents on the dollar for the first year.

(7) The Vancouver division of Hewlett-Packard reported the following benefits two years after the adoption of the JIT method:

Work-in-process inventory dollars	down 82%
Space used	down 40%
Scrap/rework	down 30%
Production time:	
Impact printers	down 7 days to 2 days
Thermal printers	down 7days to 3 hours
Labor efficiency	up 50%
Shipments	up 20%

Note: The implementation experiences listed above do not suggest a quick or across-the-board adoption of this concept. In many companies (particularly U.S. firms), the JIT purchasing concept simply may not be practical or feasible. In others, it may not be applicable to all product lines. However, many progressive companies currently are either investigating or implementing some form of the system.

JIT Costing System

Backflush costing is often used with a JIT system because it minimizes the effort devoted to accounting for inventories. It delays much of the accounting for production costs until the completion of production or even the sale of goods. Backflush costing is most appropriate when inventories are low or when the change in inventories is minimal, that is, when most production costs for a period flow into cost of goods sold. Backflush costing eliminates the work-in-process account.

The cost accounting system of a company adopting JIT will be quite simple compared to job order or processing costing. Under JIT, raw materials and work-in-process (WIP) accounts are typically combined into one account called "resources in process (RIP) or "raw and in-process." Under JIT, the materials arrive at the receiving area and are whisked immediately to the factory area. Thus, the WIP and Stores Control accounts vanish. The journal entries that accompany JIT costing are remarkably simple as follows:

Raw and in-process (RIT) inventory	45,000	
Accounts payable or cash		45,000
To record purchases		
Finished goods	40,000	
RIP inventory		40,000
To record raw materials in completed units.		

As can be seen, there is no Stores Control and WIP accounts under JIT.

In summary, JIT costing can be characterized as follows:

1. There are less inventory accounts.
2. There are no work orders. Thus, there is no need for detailed tracking of actual raw materials.
3. With JIT, activities can be eliminated on the premise that they do not add value. Prime target for elimination are storage areas for WIP inventory and material handling facilities.
4. Direct labor costs and factory overhead costs are not tracked to specific orders. Direct labor is now regarded as just another part of factory overhead. Furthermore, factory overhead is accounted for as follows. Virtually all of the factory overhead incurred each

month, now including direct labor, flows through to cost of goods sold in the same month. Tracking overhead through WIP and finished goods inventory provides no useful information. Therefore, it makes sense to treat manufacturing overhead as an expense charged directly to cost of goods sold.

Product Costing Accuracy and Cost Management with JIT

The costs of many activities previously classified as indirect costs have been transferred to the direct cost in the JIT environment. For example, under JIT system workers on the production line will do plant maintenance and setups, while under traditional systems these activities were done by other workers classified as indirect labor. Table 4 compares the traceability of some manufacturing costs under the traditional system with their traceability in the JIT environment.

We can see that JIT manufacturing increases direct traceability in many manufacturing costs, thus enhancing the accuracy of product costing. *Note:* JIT does not convert all indirect costs into direct costs. Even with JIT installed, still some overhead activities remain common to the work centers. Nonetheless, JIT, coupled with activity-based accounting (ABC), gives rise to a tremendous improvement in product costing accuracy over the traditional approach.

In traditional purchasing environments many firms place great emphasis on purchase price variances. Favorable purchasing price variances can sometimes be achieved by buying larger quantities to take advantage of price discounts or by buying lower quality materials. In JIT, the emphasis is on quality, availability, and the total cost of operations and not just the purchase price of materials.

In many traditional plants, much of the internal accounting effort is devoted to setting labor and overhead standards and in calculating and reporting variances from these standards. Firms using JIT report reduced emphasis on the use of labor and overhead variances. Even firms retaining variance analysis stress that a change in *focus* is appropriate in a JIT plant. The emphasis is on the analysis at the plant level with focus on *trends* that may be occurring in the manufacturing process rather than the absolute magnitude of individual variances.

Furthermore, traditional performance measures (such as labor efficiency and machine utilization) that are commonplace in many cost accounting systems are not appropriate within the JIT philosophy of cost management. They are all inappropriate for the following reasons:

TABLE 4
TRACEABILITY OF PRODUCT COST

TRADITIONAL VERSUS JIT MANUFACTURING

	Traditional	*JIT*
Direct Labor	Direct	Direct
Direct Materials	Direct	Direct
Material Handling	Indirect	Direct
Repairs and Maintenance	Indirect	Direct
Energy	Indirect	Direct
Operating supplies	Indirect	Direct
Supervision	Indirect	Direct
Insurance and taxes	Indirect	Indirect
Building depreciation	Indirect	Indirect
Equipment depreciation	Indirect	Direct
Building occupancy	Indirect	Indirect
Product support services	Indirect	Indirect

(a) They all promote building inventory beyond what is needed in the immediate time frame.
(b) Emphasizing performance to standard gives priority to output, at the expense of quality.
(c) Direct labor in the majority of manufacturers accounts for only 5 to 15% of total product cost.
(d) Using machine utilization is inappropriate because it encourages results in building inventory ahead of needs.

Table 5 lists typical performance measures under the traditional and JIT systems.

TABLE 5
PERFORMANCE MEASURES
TRADITIONAL VS. JIT

Traditional	*JIT*
Direct labor utilization	Return on assets
Direct labor productivity	Days of inventory
Machine utilization	Group incentives
	Lead time of product
	Response time to customer feedback
	Number of customer complaints
	Cost of quality
	Setup reduction

CHAPTER SUMMARY

This chapter discussed the basic concepts underlying the Just-In-Time (JIT) system. JIT was compared with the traditional system. Its tangible benefits were addressed. Examples of JIT implementation in the U.S. were also presented.

JIT is impacting product costing. Under JIT manufacturing, many indirect costs are converted to direct costs. This conversion reduces the need to use multiple cost drivers to assign overhead costs to products, thus enhancing product-costing accuracy. JIT simplifies the cost accounting procedure. This simplification will transform a cost "accounting" system into a cost "management" system that can be used to support management's needs for better decisions about product design, pricing, marketing, and mix, and to encourage continual operating improvements.

GLOSSARY

ACTIVITY-BASED COSTING (ABC) a costing system which first traces costs to activities and then to products. It separates overhead costs into overhead cost pools, where each cost pool is associated with a different cost driver. A predetermined overhead rate is computed for each cost pool and each cost driver. In consequence, this method has enhanced product costing accuracy.

ACTIVITY-BASED MANAGEMENT (ABM) systemwide, integrated approach that focuses management's attention on activities with the goal of improving customer value, reducing costs, and the resulting profit.

ANALYSIS OF VARIANCES (VARIANCE ANALYSIS) analysis and investigation of causes for variances between standard costs and actual costs. A variance is considered favorable if actual costs are less than standard costs; it is unfavorable if actual costs exceed standard costs. Unfavorable variances are the ones that need further investigation for their causes.

BALANCED SCORECARD approach uses multiple measures to evaluate managerial performance. These measures may be financial or nonfinancial, internal or external, and short-term or long-term. The scorecard allows a determination as to whether a manager is achieving certain objectives at the expense of others that may be equally or more important.

BENCHMARKING searching for new and better procedures by comparing your own procedures to that of the very best.

BREAK-EVEN ANALYSIS a branch of cost-volume-profit (CVP) analysis that determines the break-even sales, which is the level of sales where total costs equal total revenue.

BUSINESS PROCESS REENGINEERING (BPR) approach aiming at making revolutionary changes as opposed to evolutionary changes by eliminating non-value added steps in a business process and computerizing the remaining steps to achieve desired outcomes.

CAPACITY rate at which work is capable of being produced.

CAPITAL BUDGET a budget or plan of proposed acquisitions and replacements of long-term assets and their financing. A capital budget is developed using a variety of capital budgeting techniques such as the discount cash flow method.

CAPITAL RATIONING the problem of selecting the mix of acceptable projects that provides the highest overall net present value (NPV) where a company has a limit on the budget for capital spending.

CASH BUDGET a budget for cash planning and control presenting expected cash inflow and outflow for a designated time period. The cash budget helps management keep cash balances in reasonable relationship to its needs. It aids in avoiding idle cash and possible cash shortages.

CASH FLOW (1) cash receipts minus cash disbursements from a given operation or asset for a given period. Cash flow and cash inflow are often used interchangeably. (2) the monetary value of the expected benefits and costs of a project. It may be in the form of cash savings in operating costs or the difference between additional dollars received and additional dollars paid out for a given period.

COEFFICIENT OF DETERMINATION a statistical measure of how good the estimated regression equation is. Simply put, it is a measure of "goodness of fit" in the regression.

COMMON COSTS expense shared by different departments, products, jobs, also called joint costs or indirect costs.

CONTINUOUS IMPROVEMENT (CI) also called *Kaizen* in Japanese, never-ending effort for improvement in every part of the firm relative to all of its deliverables to its customers.

CONTRIBUTION MARGIN (CM) the difference between sales and the variable costs of the product or service, also called marginal income. It is the amount of money available to cover fixed costs and generate profits.

CONVERSION COSTS the sum of the costs of direct labor and factory overhead.

COST ACCUMULATION the collection of costs in an organized fashion by means of a cost accounting system. There are two primary approaches to cost accumulation: a job order system and process cost system.

COST BEHAVIOR ANALYSIS analysis of mixed costs. Mixed costs must be separated into the variable and fixed elements in order to be included in a variety of business planning analyses such as cost-volume-profit (CVP) analysis.

COST CENTER the unit within the organization in which the manager is responsible only for costs. A cost center has no control over sales or over the generating of revenue. An example is the production department of a manufacturing company.

COST DRIVER a factor that causes a cost item to be incurred (e.g., direct labor hours, number of setups, or number of inspections).

COST MANAGEMENT a system that measures the cost of significant activities, recognizes non-value-added costs, and identifies activities that will improve overall performance.

COST OF PRODUCTION REPORT a summary of the unit and cost data of a production department in a process cost system.

COST POOL a group of related costs that are assigned together to a set of cost objectives (such as jobs, products, or activities).

COST-VOLUME FORMULA a cost function in the form of y = a + bx. For example, the cost-volume formula for factory overhead is y = \$200 + \$10x where y = estimated factory overhead and x = direct labor hours, which means that the factory overhead is estimated to be \$200 fixed, plus \$10 per hour of direct labor. Cost analysts use the formula for cost prediction and flexible budgeting purposes.

COST-VOLUME-PROFIT (CVP) ANALYSIS analysis that deals with how profits and costs change with a change in volume. It looks at the effects on profits of changes in such factors as variable costs, fixed costs, selling prices, volume, and mix of products sold.

DEPARTMENTAL RATE a predetermined factory overhead rate for each production department.

DISCRETIONARY (FIXED) COSTS those fixed costs that change because of managerial decisions, also called management (fixed) costs or programmed (fixed) costs. Examples of this type of fixed costs are advertising outlays, training costs, and research and development costs.

DO PONT FORMULA the breakdown of return on investment (ROL) into profit margin and asset turnover.

FLEXIBLE BUDGET a budget based on cost-volume relationships and developed for the actual level of activity. An extremely useful tool for comparing the actual cost incurred to the cost allowable for the activity level achieved.

INTERNAL RATE OF RETURN (IRR) the rate of interest that equates the initial investment with the present value of future cash inflows.

INVESTMENT CENTER a responsibility center within an organization that has control over revenue, cost, and investment funds. It is a profit center whose performance is evaluated on the basis of the return earned on invested capital.

JOB ORDER COSTING the accumulation of costs by specific jobs, contracts, or orders. This costing method is appropriate when direct costs can be identified with specific units of production. Widely used by custom manufacturers such as printing, aircraft, construction, auto repair, and professional services.

JUST-IN-TIME (JIT) a demand-pull system where demand for customer output (not plans for using input resources) triggers production. Production activities are “pulled,” not “pushed,” into action. JIT, in its purest sense, is buying and producing in very small quantities just in time for use.

JUST-IN-TIME PRODUCTION approach to manufacturing in which items are produced only when needed in production.

KANBAN Japanese information system for coordinating production orders and withdrawals from in-process inventory to realize just-in-time production.

LABOR EFFICIENCY VARIANCE the difference between the amount of labor time that should have been used and the labor actually used, multiplied by the standard rate.

LABOR RATE VARIANCE any deviation from standard in the average hourly rate paid to workers.

LEAST SQUARES METHOD a statistical technique for fitting a straight line through a set of points in such a way that the sum of the squared distances from the data points to the line is minimized.

LIFE-CYCLE COSTING a costing approach, under which all product costs are accounted for in the value chain from research and development and design of products and processes through production, marketing, distribution, and customer service. It focuses on minimizing locked-in costs, for example, by reducing the number of parts, promoting standardization of parts, and using equipment that can make more than one kind of product.

MASTER (COMPREHENSIVE) BUDGET a plan of activities expressed in monetary terms of the assets, equities, revenues, and costs which will be involved in carrying out the plans. A set of projected or planned financial statements.

MATERIALS PRICE VARIANCE the difference between what is paid for a given quantity of materials and what should have been paid, multiplied by actual quantity of materials purchased.

MATERIALS QUANTITY (USAGE) VARIANCE the difference between the actual quantity of materials used in production and the standard quantity of materials allowed for actual production, multiplied by the standard price per unit.

MIXED COSTS costs that vary with changes in volume but, unlike variable costs, do not vary in direct proportion, also called semi-variable costs.

MULTIPLE REGRESSION ANALYSIS a statistical procedure that attempts to assess the relationship between the dependent variable and two or more independent variables. For example, total factory overhead is related to both labor hours and machine hours.

NET PRESENT VALUE (NPV) the difference between the present value of cash inflows generated by the project and the amount of the initial investment.

NON-VALUE-ADDED ACTIVITY activity that increases the time spent on a product or service but do not increase its worth to the customer. The designation “non-value-added” reflects a belief that the activity can be redesigned, reduced, or eliminated without reducing the quantity, responsiveness, or quality of the output required by the customer or the organization.

OPPORTUNITY COST the net benefit foregone by rejecting an alternative use of time or facilities.

OUT-OF-POCKET COSTS actual cash outlays made during the period for payroll, advertising, and other operating expenses.

OUTSOURCING acquisition of products and services from sources outside the organization instead of producing them internally.

PAYBACK PERIOD the length of time required to recover the initial amount of a capital investment.

PREDETERMINED OVERHEAD RATE an overhead rate, based on budgeted factory overhead cost and budgeted activity, which is established before a period begins.

PROCESS COSTING a cost accumulation method used to assign costs to units of a homogeneous product as the units pass through one or more processes.

PROFIT-VOLUME CHART a chart that determines how profits vary with changes in volume.

PROFITABILITY INDEX the ratio of the total present value of future cash inflows to the initial investment.

RATE OF RETURN ON INVESTMENT (ROI) (1) for the company as a whole, net income after taxes divided by invested capital. (2) for the segment of an organization, net operating income divided by operating assets, (3) for capital budgeting purposes. also called simple accounting, or unadjusted rate of return, expected future net income divided by initial (or average) investment.

REGRESSION ANALYSIS a statistical procedure for mathematically estimating the average relationship between the dependent variable (sales, for example) and one or more independent variables (price and advertising, for example).

RELEVANT COST the expected future cost that will differ between the alternatives being considered.

RESIDUAL INCOME (RI) the operating income which an investment center is able to earn above some minimum return on its assets.

RESPONSIBILITY ACCOUNTING the collection, summarization, and reporting of financial information about various decision centers (responsibility centers) throughout an organization. Also called activity accounting or profitability accounting.

RESPONSIBILITY CENTER a unit in the organization which has control over costs, revenues, or investment funds. For accounting purposes, responsibility centers are classified as cost centers, revenue centers, profit centers, and investment centers, depending on what each center is responsible for.

SALES PRICE VARIANCE the difference between actual selling price per unit and the budgeted selling price per unit, multiplied by the actual number of units sold.

SALES VOLUME VARIANCE the difference between the actual number of units sold and the budgeted number, multiplied by the budgeted selling price per unit; also called sales quantity variance.

SEGMENTED REPORTING the process of reporting activities of various segments of an organization such as divisions, product lines, or sales territories.

SHADOW PRICE profit that would be lost by not adding an additional hour of capacity.

SIMPLE REGRESSION a regression analysis which involves one independent variable. For example, total factory overhead is related to one activity variable (either direct labor hours or machine hours).

TARGET COSTING a method used in the analysis of product design that involves estimating a target cost, via a desired profit and sales price, and then designing the product/service to meet that cost.

THEORY OF CONSTRAINTS (TOC) approach seeking to identify a company's constraints or bottlenecks and exploit them so that throughput is maximized and inventories and operating costs are minimized.

THROUGHPUT the rate of production of a defined process over a stated period of time. Rates may be expressed in terms of units of products, batches produced, dollar turnover, or other meaningful measurements.

TOTAL QUALITY MANAGEMENT (TQM) concept of using quality methods and techniques to strategic advantage within firms.

VALUE CHAIN the sequence of activities that convert input into output.

VALUE CHAIN COSTING an activity-based cost model (the ABM view) that contains all of the activities in the value-chain (design, procure, produce, market, distribute/render, and post-service a product or service) of one organization.

VARIANCE (1) in statistics, the square of the standard deviation, (2) in cost analysis, the deviation between the actual cost and the standard cost.

VOLUME-BASED COST DRIVER a cost driver that is based on production volume, such as machine hours or direct-labor hours.

ZERO-BASE BUDGETING a method of budgeting in which cost and benefit estimates are built up from scratch, from the level of zero, and must be justified.