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Third Edition

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SCHAUM'S OUTLINE OF
THEORY AND PROBLEMS
OF
COST
ACCOUNTING
Third Edition

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Preface

This book, the third edition, combines previous editions of *Cost Accounting I* and *Cost Accounting II* and reflects the latest issues, concepts, and procedures in the field of cost accounting. As in prior editions, the solved problems approach is used, with emphasis on the practical application of fundamental cost accounting concepts and techniques. The student is provided with:

1. Concise definitions and explanations in easily understood terms
2. Examples which illustrate the concepts and techniques developed in each chapter
3. Fully worked-out solutions to a large range of representative problems (against which students can check their own solutions)

This volume parallels the full-year cost accounting course offered in most schools. The subject matter has been carefully coordinated with leading textbooks, so that any topic can easily be found in the table of contents or the index.

The modern use of cost accounting in all phases of business activity reflects its usefulness as a management tool for planning, control, and decision making. Indeed, the diversity of its uses has stimulated its own growth, so that today cost accounting embraces such sophisticated advances as those in quantitative techniques and decision models, productivity and performance standards, behavioral science concepts, human resources accounting, learning curve theory, and advanced marketing concepts. In addition, important changes have been made in the field. These include the establishment of the Cost Accounting Standards Board (CASB) and the examination program for the Certificate in Management Accounting (CMA) given by the National Association of Accountants (NAA). Thus, cost accounting, once concerned primarily with manufacturing operations, is now recognized as appropriate for nonmanufacturing activities of all kinds.

The topics treated in this book comprise perhaps the most difficult area of study in the accounting curriculum. Cost accounting is a highly specialized field, requiring an in-depth understanding and mastery of complex concepts and techniques that are unparalleled in other accounting courses. The theory-and-solved-problems approach of this book is designed to clarify the detailed subject matter and provide students with the practical applications they need to be completely familiar with the methodology.

In addition to its usefulness in formal course work, this book will provide excellent preparation and review for the Uniform CPA Examination and for the CMA Examination. It will also serve the needs of those interested in acquiring cost accounting knowledge through independent study, such as students majoring in business and economics areas outside accounting, and business owners, managers, and executives.

We wish to thank Jeanne Flagg, a sponsoring editor for the Schaum's Outline Series, and Jeffrey Hecht for their assistance on this project.

Ralph S. Polimeni
Sheila A. Handy

Contents

Chapter 1 THE ROLE, CONCEPTS, AND CLASSIFICATIONS OF COST ACCOUNTING

- 1.1 Place in the Company
- 1.2 Managerial Functions
- 1.3 Organization Charts
- 1.4 Line and Staff Responsibility
- 1.5 The Cost Department
- 1.6 Nature of Cost Accounting
- 1.7 Costs and Their Classification
- 1.8 Cost Systems
- 1.9 Unit Costs
- 1.10 Fixed and Variable Costs
- 1.11 Income Statements

Chapter 2 COSTING AND CONTROL OF MATERIALS AND LABOR

- 2.1 Characteristics of Materials and Labor
- 2.2 Systems of Accounting for the Purchase of Materials
- 2.3 Issuance of Materials
- 2.4 Costing Materials Issued and Ending Materials Inventory
- 2.5 Comparison of Inventory Methods
- 2.6 Lower of Cost or Market (LCM)
- 2.7 Control Procedures
- 2.8 Labor Costs
- 2.9 Overtime and Shift Premium
- 2.10 Bonus
- 2.11 Vacation and Holiday Pay
- 2.12 Pensions
- 2.13 Fringe Costs
- 2.14 Accounting for Labor

Chapter 3 FACTORY OVERHEAD AND THE FACTORY LEDGER

- 3.1 Factory Overhead Defined
- 3.2 Applied Factory Overhead
- 3.3 Base to Be Used
- 3.4 Activity Level to Be Used

- 3.5 Journalizing Factory Overhead
- 3.6 Over-or Underapplied Overhead
- 3.7 Allocation of Service Department Costs to Producing Departments
- 3.8 The Factory Ledger

Chapter 4 JOB ORDER COST SYSTEM

- 4.1 Job Order Cost System
- 4.2 Journal Entries for Job Order Cost System
- 4.3 Job Order Cost Sheet
- 4.4 Spoiled and Defective Units

Chapter 5 PROCESS COST SYSTEM

- 5.1 Introduction
- 5.2 Accumulation of Costs
- 5.3 Departmental Transfers
- 5.4 Flow of Units
- 5.5 Equivalent Units of Production
- 5.6 Cost of Production Report
- 5.7 Journal Entries
- 5.8 Second Department and Introduction of Additional Materials
- 5.9 Cost of Production Report—Second Department
- 5.10 Spoiled Units (Goods)
- 5.11 Accounting for Spoiled Units

Chapter 6 BY-PRODUCT AND JOINT PRODUCT COSTING

- 6.1 Joint Costs
- 6.2 Difficulties Associated with Joint Costs
- 6.3 By-Products Defined
- 6.4 Accounting for By-Products
- 6.5 Joint Products Defined
- 6.6 Accounting for Joint Products

Chapter 7 THE MASTER BUDGET

- 7.1 Nature of the Budget
- 7.2 Developing the Master Budget
- 7.3 Sales Budget
- 7.4 Production Budget
- 7.5 Direct Materials Purchase Budget

- 7.6 Direct Materials Usage Budget
- 7.7 Direct Labor Budget
- 7.8 Factory Overhead Budget
- 7.9 Ending Inventories Budget
- 7.10 Cost of Goods Sold Budget
- 7.11 Selling Expense Budget
- 7.12 Administrative Expense Budget
- 7.13 Budgeted Income Statement
- 7.14 Cash Budget
- 7.15 Budgeted Balance Sheet

Chapter 8 STANDARD COSTS AND GROSS PROFIT ANALYSIS

- 8.1 Standard Costs Defined
- 8.2 Types of Standards
- 8.3 Establishment of Standards
- 8.4 Establishing Standards in Process and Job Order Cost Systems
- 8.5 Quality Control
- 8.6 Just-in-Time Philosophy
- 8.7 Variance Analysis
- 8.8 Computation of Variances
- 8.9 Journal Entries in a Standard Cost System
- 8.10 Disposition of All Variances
- 8.11 Gross Profit Analysis Defined
- 8.12 Change in Gross Profit
- 8.13 Multiproducts

Chapter 9 DIRECT COSTING, BREAK-EVEN ANALYSIS, AND COST-VOLUME-PROFIT PLANNING

- 9.1 Meaning of Direct Costing
- 9.2 Direct Costing: Product and Period Costs
- 9.3 Direct Costing vs. Absorption Costing: Income Statements
- 9.4 Uses of Direct Costing
- 9.5 Advantages and Disadvantages of Direct Costing
- 9.6 Use of Break-Even Analysis
- 9.7 Equation Method
- 9.8 Contribution Margin Method
- 9.9 Graphic Method
- 9.10 Use of Cost-Volume-Profit Planning
- 9.11 Risk and Profit Analysis

Chapter 10 CAPITAL BUDGETING

- 10.1 Capital Budgets
- 10.2 Methods of Evaluation
- 10.3 Payback Method
- 10.4 Accounting Rate of Return
- 10.5 Internal-Rate-of-Return Method (IRR)
- 10.6 Net-Present-Value Method (NPV)
- 10.7 Index of Profitability Method (IP)
- 10.8 Discounted-Payback Method
- 10.9 Replacement Chains
- 10.10 Computation of Cash Flow from Operations

Chapter 11 RELEVANT COSTING IN DECISION MAKING AND PERFORMANCE MEASUREMENT

- 11.1 Introduction
- 11.2 Relevant vs. Irrelevant Costs
- 11.3 Differential or Incremental Costs
- 11.4 Sunk Costs
- 11.5 Opportunity Costs
- 11.6 Segmental Analysis
- 11.7 Discontinuing a Segment
- 11.8 Sell or Process Further
- 11.9 Special Orders—Accept or Reject
- 11.10 Make-or-Buy Decisions
- 11.11 Product Mix Decision
- 11.12 Approaches to Performance Measurement
- 11.13 Return on Investment
- 11.14 Return-on-Investment Ratio
- 11.15 Advantages and Disadvantages of ROI
- 11.16 Total Company Evaluation
- 11.17 Divisional Evaluation
- 11.18 Residual Income

Chapter 12 DECISION THEORY AND ECONOMIC ORDER QUANTITY

- 12.1 An Outline of the Decision-Theory Method
- 12.2 General Approach to Uncertainty
- 12.3 Project Proposals and Uncertainty

- 12.4 Program Evaluation Review Technique (PERT) and Uncertainty
- 12.5 Inventory Costs and Control—Economic Order Quantity
- 12.6 Determination of Economic Order Quantity
- 12.7 Inventory Order Point
- 12.8 Safety Stock
- 12.9 Inventory Stockouts and Uncertainty

Chapter 13 DECENTRALIZED OPERATIONS, RESPONSIBILITY ACCOUNTING, AND TRANSFER PRICING

- 13.1 Introduction
- 13.2 Concepts of Organization
- 13.3 Functional Approach
- 13.4 Product Approach
- 13.5 Geographic Approach
- 13.6 Advantages and Disadvantages of Decentralization
- 13.7 Nature of Responsibility Accounting
- 13.8 Responsibility Centers
- 13.9 Essentials of Control
- 13.10 Responsibility Accounting Reports
- 13.11 Essentials of Good Performance Reports
- 13.12 Significance of Transfer Pricing
- 13.13 Objectives of Transfer Pricing
- 13.14 Transfer Pricing Methods
- 13.15 Cost Method
- 13.16 Cost Plus Method
- 13.17 Market Price Method
- 13.18 Negotiated Price Method
- 13.19 Dual Prices Method
- 13.20 Incremental Costs Method
- 13.21 Accounting Entries

INDEX

Chapter 1

The Role, Concepts, and Classifications of Cost Accounting

1.1 PLACE IN THE COMPANY

Cost accounting provides management with costs for products, inventories, operations or functions and compares actual to predetermined data. It also provides a variety of data for many day-to-day decisions as well as essential information for long-range decisions.

1.2 MANAGERIAL FUNCTIONS

The managerial functions are carried out by the *top management group*, the president, vice-presidents and other executives; the *middle management group*, the division managers, branch managers and department heads; and the *lower management group*, the supervisors. These groups require comprehensive analytic cost data provided on a timely and systematic basis. Essentially the various managerial groups assist in establishing company objectives and determining that the objectives are realized. There are four basic managerial functions that are common to all activities, no matter how large or small the enterprise: (1) planning, (2) organizing, (3) directing, and (4) controlling.

Planning. The process of establishing organizational goals (i.e., setting objectives) and a strategy for their accomplishment is known as planning. It is concerned with the future—immediate and/or long range. Middle and lower management planning stems from the goals (i.e., the plan) set by top management. Examples of primary objectives are improvements in market standing, productivity, profitability, managerial performance, and public responsibility.

Organizing. Once objectives are set and a basic plan is established, the process of organizing involves developing a framework for the activity and making specific work assignments. *Authority* originates with top management and is delegated to the various management levels. A closely related factor is *responsibility*—the obligation to account for a particular function. The supervisor has the authority to delegate the particular work, the employee has the responsibility for performance. *Accountability*—a facet of responsibility—is the obligation to report results to higher authority. This is an important feature of budgetary control and standard costing, since it aids in the comparison of actual performance with predetermined standards and an analysis of causes of difference.

Directing. This is the process by which management achieves its objectives. It requires the ability to supervise and motivate employees in order to obtain optimal levels of productivity conforming to established plans (e.g., budgets or standards for sales, production, costs, etc.)

The modern concept of motivation involves creating a work environment that stimulates superior levels of productivity. On the manager's part, it means providing subordinates with a clear picture of what is expected, necessary guidance, and the feeling that their work represents an important contribution to the achievement of the enterprise's ultimate goals. By effectively communicating with employees and

encouraging feedback from them, managers are able to satisfy employee needs.

Controlling. The process of review, evaluation and reporting monitors the achievement of goals. It involves comparing actual results with those projected in planning as well as against actual performance in past periods. There are two facets to reviewing the enterprise's activities: (1) the comparison of actual to projected results and (2) individual traits. This is done because discrepancies on paper can often be traced to employee achievements and/or failures (e.g., good and bad decisions, exceptional or insufficient supervision and motivation, etc.)

Another kind of appraisal is the *internal audit*. This is a systematic review and evaluation made by a staff of internal auditors to assure management that established controls are operating as planned. Internal auditing today covers accounting, financial and other business operations, such as evaluations of policies, managerial performance, methods, *etc.* An important part of any review is the reporting of deficiencies and effective recommendations for their prompt correction.

1.3 ORGANIZATION CHARTS

An organization chart establishes the flow of authority and responsibility by defining the relationships among the major management positions of the enterprise. As such, it identifies those persons to whom the various kinds of cost accounting information (see [Section 1.5](#)) should go.

For purposes of cost accounting there are two organization charts that we should consider:

- (1) **Company Chart.** This chart depicts the flow of authority and responsibility downward from the stockholders, through the Board of Directors, the President, the respective Vice-Presidents and other executives to the operating levels. See [Fig. 1-1](#).

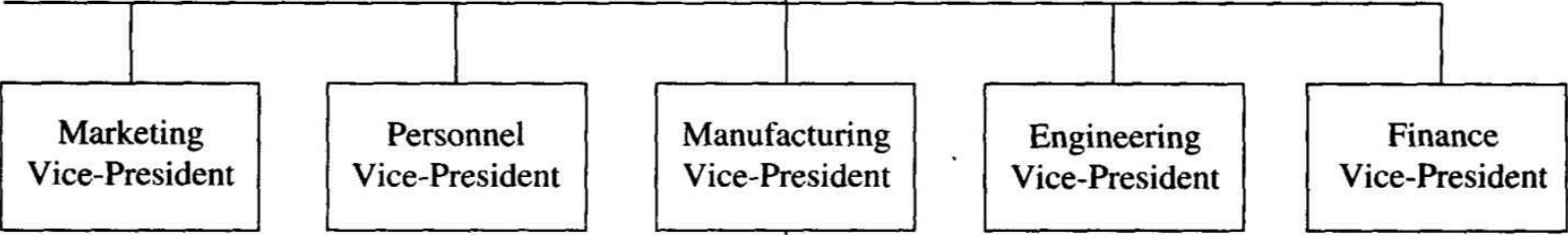
Stockholders

Board
of
Directors

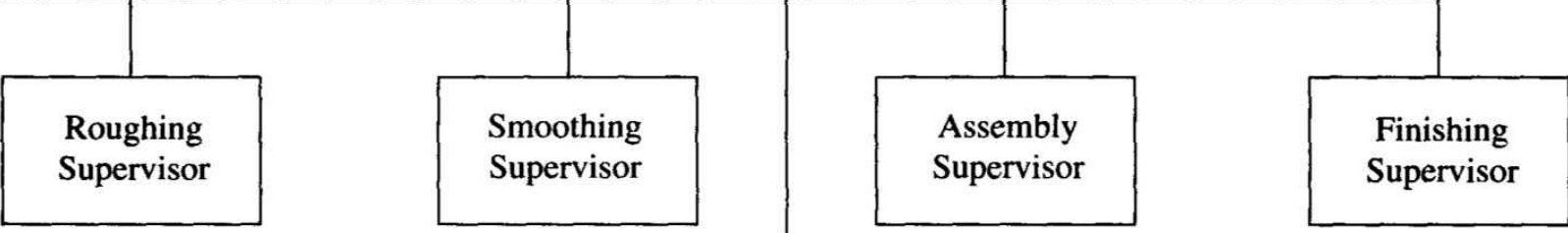
President

Corporate
Secretary

Line Departments



Production Departments



Service Departments

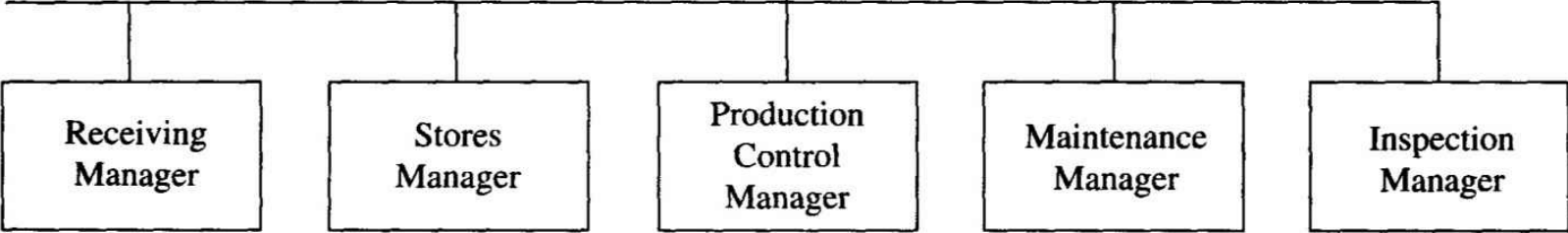


Fig. 1-1. Organization Chart of a Manufacturing Company

- (2) ***Controller's Division Chart.*** The controller is the top accounting officer in the company. As a member of the top management team, his or her attention should be directed to providing services to all levels of management and to all functions of the company. The technical and detailed activities for which the controller is responsible are prepared by a staff of specialized accountants. See [Fig. 1-2](#).

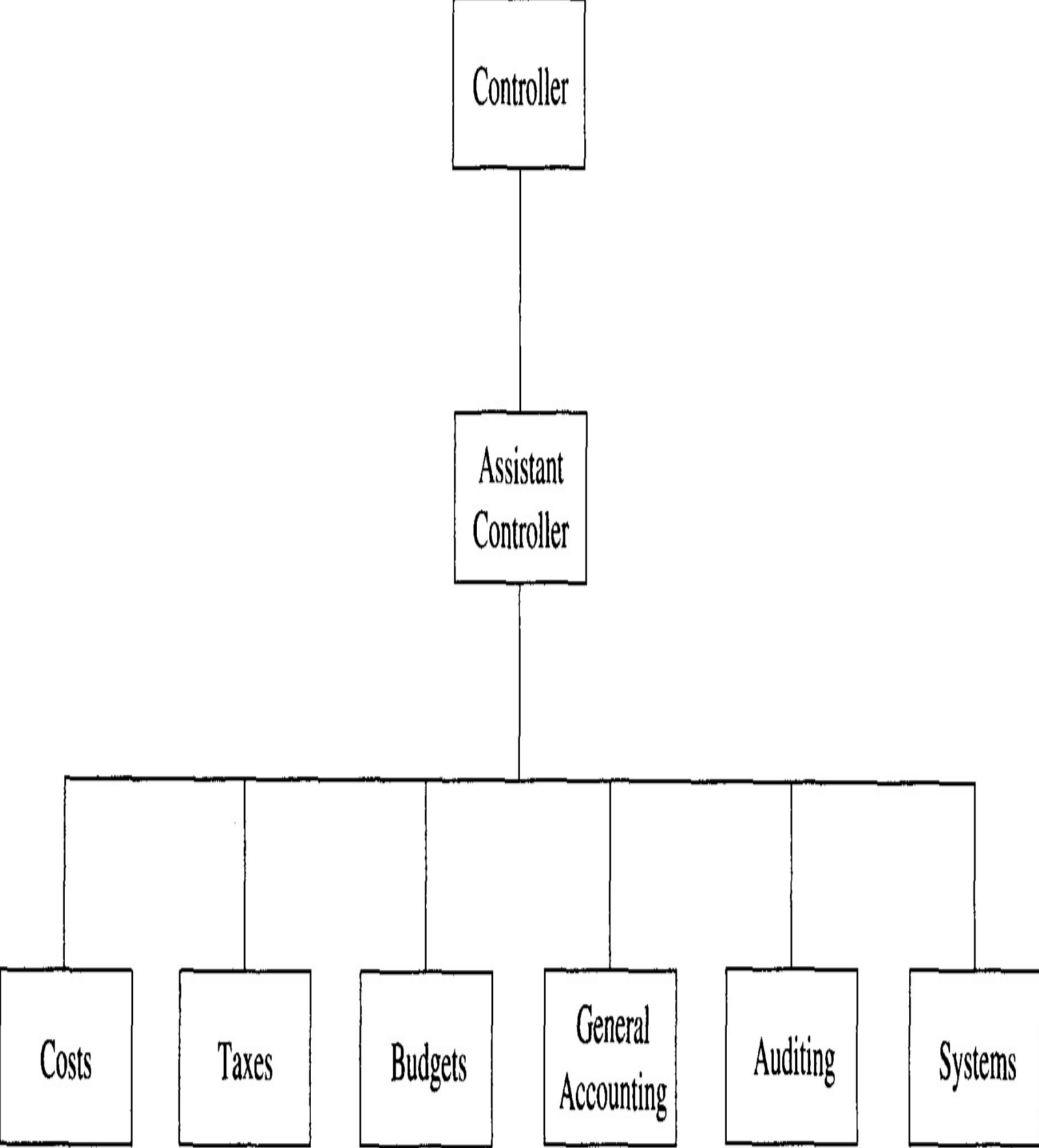


Fig. 1-2. Controller's Division Organization Chart

1.4 LINE AND STAFF RESPONSIBILITY

Most responsibilities in a company can be divided into line and staff functions. The *line function* has

the responsibility for decision making, guidance and supervision. The *staff function* provides advice and service to the line function, but cannot require implementation of its findings. Thus, the controller has line responsibilities (i.e., those that affect his or her own department) as well as staff responsibility with respect to other departments.

1.5 THE COST DEPARTMENT

The cost department is usually supervised by a controller or chief cost accountant. It is responsible for developing and reporting cost data with respect to materials, labor and overhead, and maintaining the necessary underlying records.

The extent to which the cost department participates in management decisions is prescribed by the definition of cost accounting used by the company. In some cases, the cost department is responsible only for compiling product costs, and has no part in analysis for decision making. In others, the wide variety of cost data needed in making day-to-day operating decisions is provided by a staff of cost accountants who have the ability to provide all types of cost information. See [Section 1.6](#).

EXAMPLE 1

Suppose that a manufacturing firm must decide whether to produce a part necessary for one of its products or purchase it from a supplier. Under the limited definition of cost accounting, the cost computations needed for the decision would not be made by the cost department. In the broader sense, the cost department would be responsible for such computations as well as any related analyses.

1.6 NATURE OF COST ACCOUNTING

The broad definition of cost accounting is *the process of identifying, summarizing and interpreting information needed for (1) planning and control, (2) management decisions, and (3) product costing*. Note that product costing is number 3, since in most companies the more important activities relate to planning and control and special decisions rather than to the more mechanical aspects of accumulating and computing product costs.

The various activities of a cost department under the broad definition cover a wide range of responsibilities:

- (1) Preparing data required in planning and controlling operations.
- (2) Preparing data in connection with day-to-day decisions or special projects that require a choice among alternative courses of action.
- (3) Participating in the creation and execution of budgets.
- (4) Establishing procedures to improve operations and reduce costs.
- (5) Developing cost systems and analyses to improve cost determination and review of variances.
- (6) Cost recording and reporting of costs by product or department.

The concepts of *cost*, *expense*, and *loss* are often used interchangeably. The AICPA, in Accounting Terminology Bulletin No. 4, defines these terms as follows:

Cost is “the amount, measured in money, of cash expended or other property transferred, capital stock issued, services performed, or a liability incurred, in consideration of goods or services received or to be received.”

Expense is “all expired costs which are deductible from revenues.” Revenue is defined as the price of goods sold and services rendered. In a narrower sense “the term ‘expense’ refers to operating, selling, or administrative expenses, interest, and taxes.” Items included in cost of manufacturing, such as materials, labor, and overhead, should be described as costs, not expenses.

Loss is “(1) the excess of all expenses, in the broad sense of that word, over revenues for a period, or (2) the excess of all or the appropriate portion of the cost of assets over related proceeds, if any, when the items are sold, abandoned, or either wholly or partially destroyed by casualty or otherwise written off. When losses such as those described in (2) are deducted from revenues, they are expenses in the broad sense of that term.”

1.7 COSTS AND THEIR CLASSIFICATION

Classification of costs is necessary in order to determine the most suitable method of accumulating and allocating cost data. The principal methods of accumulating costs are described below.

(1) Function

Manufacturing. Costs applied to producing a product.

Marketing. Costs incurred in selling a product or service.

Administrative. Costs incurred in policy-making activities.

Financial. Costs related to financial activities.

(2) Elements

Direct material. Material which is an integral part of the finished product.

Direct labor. Labor applied directly to components of the finished product.

Factory overhead. Indirect materials, indirect labor, and the manufacturing expenses that cannot easily be allocated directly to specific units, jobs or products.

(3) Product

Direct. Costs which are charged directly to the product.

Indirect. Costs which must be allocated.

(4) Department

Production. A unit in which operations are performed on the part or product.

Service. A unit not directly engaged in production and whose costs are ultimately allocated to a production unit.

(5) When Charged to Income

Product. Costs included when product costs, as defined above, are computed. Product costs are included in inventory when the product is produced and in cost of sales when the product is sold.

Period. Costs associated with the passage of time rather than with the product. These costs are not inventoried and are closed to income summary each period since no future benefits are expected.

(6) Relation to Volume

Variable. Costs which change in total in direct proportion to changes in related activity. The unit cost remains the same over a wide range of volume (referred to as the relevant range).

Fixed. Costs which do not change in total over wide ranges of volume. The unit costs decrease as volume increases.

(7) Period Covered

Capital. Costs which are expected to benefit future periods and are classified as assets.

Revenue. Costs which benefit only the current period and are thus expensed as incurred.

(8) Degree of Averaging

Total. The cumulative cost for the established category.

Unit. The total cost divided by the number of units of activity or volume.

1.8 COST SYSTEMS

The cost system must be closely tailored to the organizational structure of the company, the manufacturing process, and the type of information desired and required by executives. Numerous cost systems exist, each with its own advantages and disadvantages. The principal types of cost systems, classified according to their particular attribute, are described below.

- (1) Periodic Cost Accumulation Systems.** These provide only limited cost information during a period and require quarterly or year-end adjustments to arrive at the cost of goods manufactured. Periodic physical inventories must be taken to adjust inventory accounts and arrive at the cost of goods manufactured. A periodic cost accumulation system is *not* considered a complete cost accumulation system since the costs of work in process and finished goods can only be determined after physical inventories are taken. Because of this limitation, periodic cost accumulation systems are generally used by small manufacturing companies.
- (2) Perpetual Cost Accumulation Systems.** These provide continuous information about work in process, finished goods, and cost of goods manufactured. Cost data are accumulated through a

work-in-process account. These systems are used by most medium and large manufacturing companies. Perpetual cost accumulation systems are usually organized under either of two cost formats:

Job Order Cost. The cost unit is the job, and costs are accumulated by job. This format is most suitable where each job or order is different, such as in a printing shop.

Process Cost. The cost unit is the average cost for the units produced in a specified period of time. This format is most suitable where a high volume of similar products are produced, such as in a paper mill.

1.9 UNIT COSTS

The total cost figure is usually unsatisfactory from a control standpoint since the quantity of production varies greatly from period to period. Therefore, some common denominator, such as unit costs, must be available for comparison of varying volumes and amounts. The unit cost figure can be readily computed by dividing total costs by the number of units produced. Unit costs may be stated in terms of tons, gallons, pounds, feet, individual units, *etc.*

EXAMPLE 2

Unit costs facilitate the computation of amounts for closing inventory and for cost of goods sold. For example, assume that 3,000 units are produced at a total cost of \$4,500, or \$1.50 per unit. If 2,500 units are sold and 500 remain in inventory, the computation is as follows:

Description	Units	Cost	Unit Cost
Production cost	3,000	\$4,500	\$1.50
Cost of goods sold			
(2,500 units @ \$1.50)	<u>2,500</u>	<u>3,750</u>	<u>1.50</u>
Closing inventory			
(500 units @ \$1.50)	<u>500</u>	<u>\$ 750</u>	<u>\$1.50</u>

1.10 FIXED AND VARIABLE COSTS

For proper budgeting and cost control it is necessary to make a distinction between *fixed* and *variable* total costs. Most costs fit easily into one category or the other; however, various items of factory overhead can be classified as *semivariable* costs and must be carefully examined to determine their relationship to changes in the volume of production.

Fixed Costs. Those which continue unchanged in total within a relevant range despite wide fluctuations in volume or activity. There is a fluctuation in fixed cost *per unit* with volume change. Examples of fixed costs are property taxes and production executives' salaries.

Variable Costs. Those which change in total in direct proportion to changes in volume or activity. There is a uniform cost *per unit* with changes in volume or activity within the relevant range of production. Direct materials and direct labor are generally considered variable costs. Included in this category are such items as factory supplies and payroll taxes.

Semivariable Costs. Those which vary but not in direct proportion to volume or activity. For example, the payroll department costs may remain unchanged up to a certain number of production employees. Additional volume usually requires additional production employees and causes an increase in the payroll department costs. Other examples of semivariable costs are salaries of production department supervisors and machinery repairs.

1.11 INCOME STATEMENTS

The income statements of a manufacturing company and a merchandising company reflect the basic difference in operations of these two types of enterprises. The manufacturing company transforms raw material into finished goods through the use of labor and factory facilities (for example, a company producing finished furniture from lumber). A merchandising company, such as a retail furniture store which buys finished furniture and sells it in the same form, sells the goods it buys without changing the basic form. Note, however, that a merchandising company has only one inventory, while a manufacturing company has three inventories: raw materials, work in process, and finished goods.

The work-in-process inventory account is used to accumulate all factory costs. Direct materials are usually recorded into work-in-process inventory from material requisitions. Direct labor is accumulated into work-in-process inventory from payroll records. All other factory costs (factory overhead) are generally applied into work-in-process inventory based on a predetermined denominator base (discussed in [Chapter 3](#)). These inputs into work-in-process inventory (direct materials, direct labor and factory overhead) are called manufacturing costs. The credit to the work-in-process inventory account represents the cost of goods manufactured.

EXAMPLE 3

In the Cost of goods sold section of the Augusta Manufacturing Company's income statement, there is a caption *Cost of goods manufactured*. On the comparable line of the Locust Valley Merchandising Company's statement is the caption *Purchases*. The latter caption indicates that goods similar to those in the opening and closing merchandise inventory have been bought during the accounting period. The caption *Costs of goods manufactured* represents the total of materials, labor, and overhead used in manufacturing the product and is detailed in the supporting schedule of cost of goods manufactured. As can be seen, the schedule shows the direct materials, the direct labor, and the various components of factory overhead that apply. The term cost of goods manufactured relates to the cost of products which have been *fully completed and transferred to finished goods*. The products which have not been completed will remain in the work-in-process inventory at the end of the period.

Augusta Manufacturing Company

Income Statement

for year ended December 31, 19X1

Locust Valley Merchandising Company

Income Statement

for year ended December 31, 19X1

Sales	<u>\$2,100,000</u>
Less: Cost of goods sold	
Finished goods, Jan. 1, 19X1	\$ 180,000
→ Cost of goods manufactured (see Schedule of Cost of Goods Manufactured)	1,500,000
	<u>\$1,680,000</u>
Finished goods, Dec. 31, 19X1	<u>150,000</u>
Cost of goods sold	<u>\$1,530,000</u>
Gross profit	\$ 570,000
Less: Selling and administrative expense	<u>250,000</u>
Net income	<u><u>\$ 320,000</u></u>

Sales	<u>\$2,150,000</u>
Less: Costs of goods sold	
Merchandise inventory Jan. 1, 19X1	\$ 150,000
Purchases	<u>1,550,000</u>
	<u>\$1,700,000</u>
Merchandise inventory Dec. 31, 19X1	<u>175,000</u>
Cost of goods sold	<u>\$1,525,000</u>
Gross profit	\$ 625,000
Less: Selling and administrative expense	<u>275,000</u>
Net income	<u><u>\$ 350,000</u></u>

Augusta Manufacturing Company
Schedule of Cost of Goods Manufactured
for year ended December 31, 19X1

Direct Materials:	
Inventory, Jan. 1, 19X1	\$ 170,000
Purchase of direct materials	<u>1,050,000</u>
	\$1,220,000
Inventory, Dec. 31, 19X1	<u>120,000</u>
Direct materials used	\$1,100,000
Direct labor	250,000
Factory overhead	
Indirect labor	\$ 70,000
Supplies	15,000
Heat, light and power	23,000
Depreciation, plant	20,000
Depreciation, equipment	30,000
Miscellaneous	<u>7,000</u>
Manufacturing costs	<u>\$1,515,000</u>
Add: Work in process, Jan. 1, 19X1	<u>90,000</u>
	\$1,605,000
Less: Work in process, Dec. 31, 19X1	<u>105,000</u>
Cost of goods manufactured (to Income Statement)	<u><u>\$1,500,000</u></u>

Solved Problems

1.1 Centralization vs. Decentralization. The Georgia Atlantic Paper Company, which has its headquarters and manufacturing operations in the southeast, has as its principal product kraft wrapping paper. The company recently increased its production substantially and, for product outlets, acquired four corrugated box plants located in Canton, Massillon, Akron, and Springfield, Ohio. Two bag manufacturing plants, located in Hempstead and Locust Valley, New York, were also acquired. This expansion required decentralization of much of the manufacturing operations, and there has been considerable discussion of decentralization of the accounting operations as well.

Your firm has been performing this company's audit for years and you have been asked to carry out a Management Services Survey. Prepare a report covering the following points:

- (a) Should the accounting and cost functions be decentralized?
- (b) If so, to whom should the accountant report? Should the local accountant have line, staff or functional responsibilities?
- (c) What are some of the advantages of decentralization?

SOLUTION

- (a) When manufacturing operations are decentralized, it is generally desirable to decentralize the accounting function in order to better serve the newly diversified and widespread operations. It would not be practical to expect a plant manager to wait for cost accounting answers to the many everyday cost problems which arise. Instead, there should be a trained accountant at each plant or available at a nearby plant to answer cost questions promptly.
- (b) The local accountant should report on a *line* basis or administratively to the local plant manager. He or she would have *staff* responsibility with respect to other departments. The accountant could advise but not command departments other than his or her own. The local accountant is a member of the plant unit or organization and is thus subject to the jurisdiction of the plant manager in all areas except accounting. Thus, the accountant and his or her staff would be expected to observe the working conditions established for the plant.

However, the chart of accounts, the preparation and filing of financial statements and reports would be a *functional* matter established by the controller in accordance with authority delegated by the president. Uniformity in accounting reports is required since consolidated financial data are submitted to stockholders, government agencies, *etc.* The local accountant would also prepare the many studies, analyses, and other cost information essential to local management. With the greater diversity and geographic distribution of operations and the greater need for lateral command, there is now a far greater understanding of the functional authority necessary in a large company with widespread operations.

- (c) The advantages of decentralization include the following:

- (1) Company accounting policies and procedures established by the corporate controller can be interpreted, implemented, and enforced by the local accountant.
- (2) Decision making at the local level provides good management training for advancement within the company.
- (3) An alert accountant can provide information needed by management in controlling and reducing costs and improving operations. The accountant can also greatly enhance the value of the department and increase the appreciation of the contribution that accounting can make.

1.2 Corporate Responsibilities. You have just been appointed Controller of the Fulton Company, which has grown rapidly in recent years. This expansion has brought about the need to reorganize various corporate responsibilities. The present responsibilities are as follows:

Name

Present Responsibilities

Helen L. Johnson	President and Production Manager
Lloyd Smith	Vice-President in Charge of Production
Alfred Knowles	Manager of Accounting
Roberta Harter	Vice-President in Charge of Sales
Jennifer Lyons	Chief Accountant
Thomas Reilly	Manager of Design
Frank Weag	Purchasing Agent
Ray Lanuto	Manager of Maintenance
Georgina Kuezek	Vice-President of Engineering

(a) Prepare an organization chart showing the proper arrangement of functions, and (b) describe the proposed changes in duties and titles.

SOLUTION

(a) See [Fig. 1-3](#).

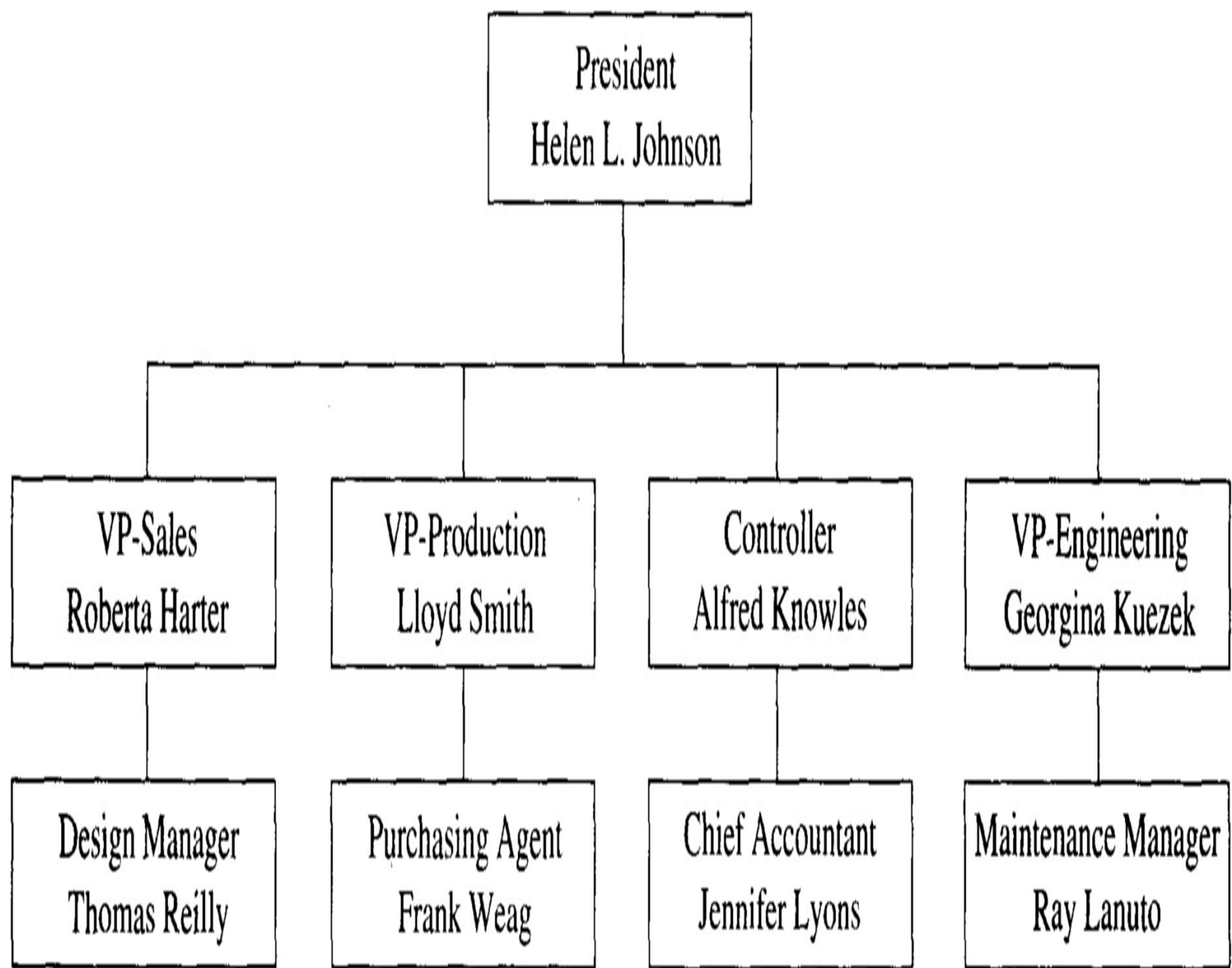


Fig. 1-3

(b) In order to avoid confusion regarding the direct responsibility for production. Lloyd Smith, the Vice-President, should be given the direct responsibility commensurate with his ability for the production function. Of course, he would be responsible to the President and perhaps a limit might be placed on contracts which the Vice-President could approve. Contracts for higher amounts would have to be approved by the President.

The title of Alfred Knowles as Manager in Charge of Accounting should be changed to Controller, the currently accepted terminology for the chief accounting officer.

The title of Roberta Harter as Vice-President in Charge of Sales might be changed to VP-Sales to be consistent with the titles of the other Vice-Presidents.

1.3 Organization Chart. The Samson Manufacturing Company has the following job classifications:

Vice-President, Marketing	Manager, Production Control
Manager, Costs	Department
Manager, Purchasing Department	Supervisor, Drilling Department
Supervisor, Finishing Department	Manager, Inspection Department
President	Supervisor, Assembly Department
Manager, Shipping Room	Manager, New Products
Vice-President, Personnel	Manager, Basic Research
Manager, Branch Sales	Manager, Product Improvement
Vice-President, Research and	Manager, Job Evaluation
Development	Manager, Engineering Services

Manager, Budgets
Controller
Manager, Employment
Vice-President, Finance
Manager, Receiving Department
Corporate Secretary
Manager, Market Research
Vice-President, Engineering
Manager, Internal Auditing
Supervisor, Machining Department

Treasurer
Manager, Engineering Design
Assistant Treasurer
Manager, Systems
Vice-President, Manufacturing
Manager, General Accounting
Superintendent of Production
Manager, Receiving Department
Manager, Stores Department
Manager, Maintenance Department

Prepare an organization chart showing the relationship among the various areas of responsibilities.

SOLUTION

See [Fig. 1-4](#).

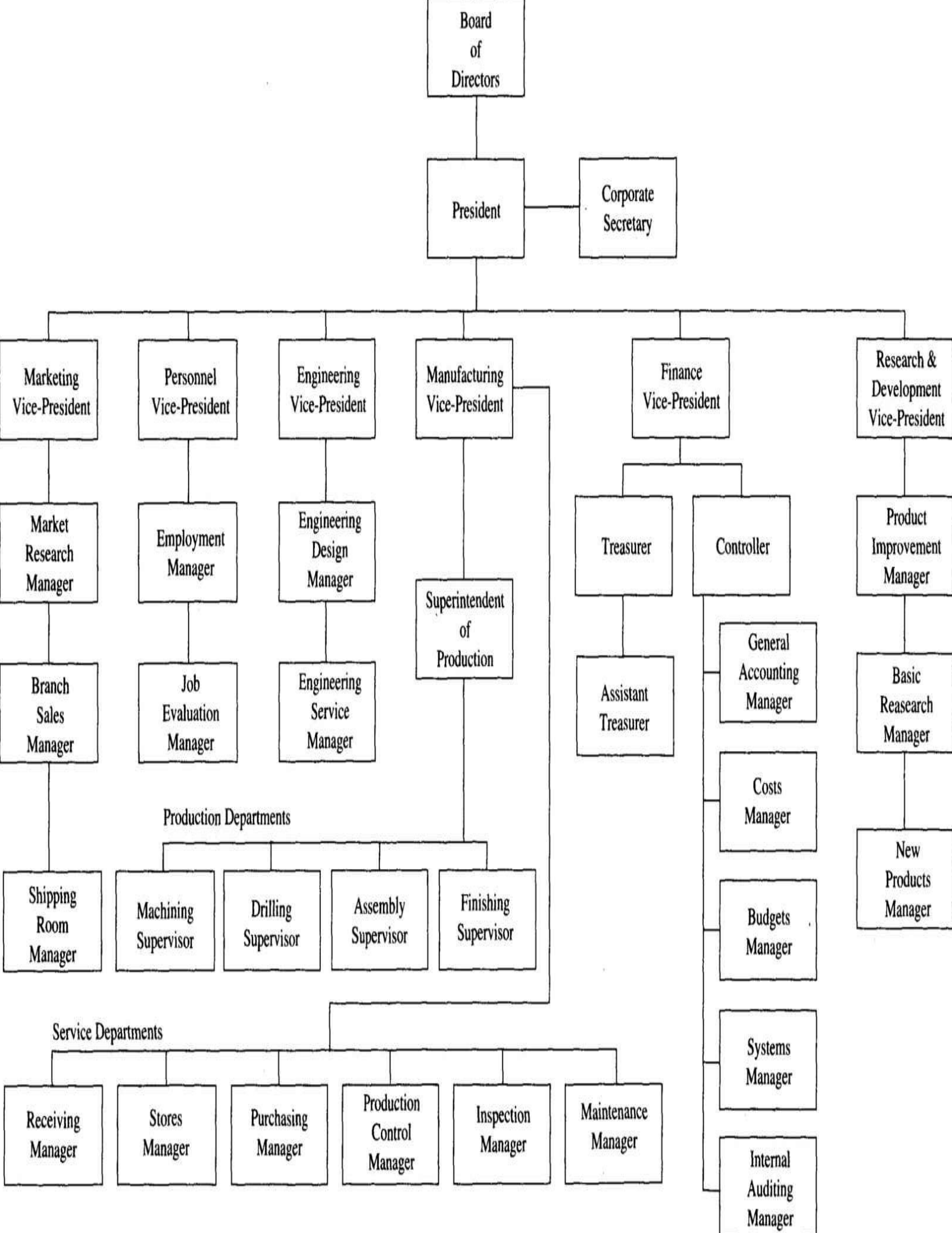


Fig. 1-4

1.4 Indicate whether the relationship of the first individual to the second in the following pairs is of a line (L) or staff (S) nature, (a) VP-Finance, Controller; (b) VP-Manufacturing, Controller; (c) Controller, Cost Accountant; (d) Controller, Production Superintendent; (e) VP-Finance, Employment Manager; (f) VP-Finishing Dept., Manufacturing Supervisor; (g) Cost Accountant, Cost Clerk; (h) Cost Accountant, General Accountant; (i) Treasurer, Assistant Treasurer.

SOLUTION

(a) L, (b) S, (c) L, (d) S, (e) S, (f) L, (g) L, (h) S, (i) L.

1.5 Cost Elements. Indicate whether the cost element for each of the following cost components is direct materials (DM), direct labor (DL) or factory overhead (FO).

- (a) Fire insurance on equipment
- (b) Machine operator's wages
- (c) Bags in cement mills
- (d) Cutting tools
- (e) Machinery repairs
- (f) Supervisor's wages
- (g) Bottles for product
- (h) Cost Accountant's salary

SOLUTION

(a) FO, (b) DL, (c) DM, (d) FO, (e) FO, (f) FO, (g) DM, (h) FO.

1.6 Fixed and Variable Costs. Indicate whether each of the following items represents a fixed (F), variable (V) or semivariable (S) cost.

- (a) Rent
- (b) Production department supervisors
- (c) Cutting tools
- (d) Property taxes
- (e) Production executive salaries
- (f) Factory power (No minimum fee)
- (g) Factory manager
- (h) Machinery repairs

SOLUTION

(a) F, (b) S, (c) V, (d) F, (e) F, (f) V, (g) F, (h) S.

1.7 Income Statement. The records of Folk, Incorporated show the following data for November, 19X7.

Inventory Balances	November 1	November 30
Raw materials	\$12,000	\$13,500
Work in process	15,100	17,600
Finished goods	19,500	21,200

Operating data:

Direct labor cost	\$ 50,000
Factory overhead	62,500
Purchases	43,200
Sales	250,000
Selling expenses	23,000
General and administrative expenses	25,000

Prepare (a) a schedule showing the cost of goods sold, and (b) an Income Statement.

SOLUTION

(a)

Folk, Incorporated
Schedule of Cost of Goods Sold
for month of November, 19X7

Raw materials cost

Raw materials inventory,

November 1

\$12,000

Purchases

43,200

Goods available

\$55,200

Less: Raw materials inventory,

November 30

13,500

Raw materials cost

\$ 41,700

Direct labor cost

50,000

Factory overhead

62,500

Total manufacturing cost

\$154,200

Add: Work in process,

November 1

15,100

\$169,300

Less: Work in process, November 30	17,600
	<u>17,600</u>
Cost of goods manufactured	\$151,700
Add: Finished goods inventory, November 1	
	19,500
	<u>19,500</u>
	\$171,200
Less: Finished goods inventory, November 30	
	21,200
	<u>21,200</u>
Cost of goods sold	<u><u>\$150,000</u></u>

(b)

Folk, Incorporated
Income Statement
for month of November, 19X7

Sales		\$250,000
Less: Cost of goods sold (see schedule)		<u>150,000</u>
Gross profit on sales		\$100,000
Operating expenses		
Selling expenses	\$23,000	
General and administrative expenses	<u>25,000</u>	<u>48,000</u>
Net income from operations		<u><u>52,000</u></u>

1.8 Fixed and Variable Costs. The Englewood Company produces a large excavator selling for \$400 per unit, of which cost of goods sold amounts to \$320 and selling and administrative expenses, \$25. During 19X5, 2,500 units were sold. The breakdown of cost of goods sold was: materials, 50%; labor, 25%; factory overhead, 25%.

The following cost increases are expected in 19X6: materials, 15%; labor, 20%. The selling price is to be raised to \$460, but management anticipates an accompanying 20% decrease in the number of units sold.

- Prepare an Income Statement for 19X5, including costs per unit.
- Prepare an Income Statement for 19X6, including unit costs. Material and labor costs are to be held to 75% of cost of goods sold; selling and administrative expenses increase to \$35 per unit.
- It was later found that 19X5 factory overhead consisted of \$125,000 in fixed expenses and \$75,000 in variable expenses. Prepare a revised Income Statement for 19X6, ignoring the previous relationship of materials and labor to cost of goods sold. Fixed costs will remain constant despite the decrease in units sold.

SOLUTION

(a)

Englewood Company *Income Statement*

Year 19X5

	Total	Per Unit
Sales (2,500 units)	<u>\$1,000,000</u>	<u>\$400.00</u>
Cost of goods sold		
Materials (50%)	\$ 400,000	\$160.00
Labor (25%)	200,000	80.00
Factory overhead (25%)	<u>200,000</u>	<u>80.00</u>
Total cost of goods sold	<u>\$ 800,000</u>	<u>\$320.00</u>
Gross profit	\$ 200,000	80.00
Selling and administrative expenses	<u>62,500</u>	<u>25.00</u>
Net profit	<u><u>\$ 137,500</u></u>	<u><u>\$ 55.00</u></u>

(b)

Englewood Company
Income Statement
Year 19X6

	Total	Per Unit
Sales (2,000 units)	<u>\$920,000</u>	<u>\$460.00</u>
Cost of goods sold		
Materials (\$160 × 115%)	\$368,000	\$184.00
Labor (\$80 × 120%)	192,000	96.00
Factory overhead (25% of cost of goods sold)	<u>186,667*</u>	<u>93.33</u>
Total cost of goods sold	<u>\$746,667</u>	<u>\$373.33</u>
Gross profit	\$173,333	\$ 86.67
Selling and administrative expenses	<u>70,000</u>	<u>35.00</u>
Net profit	<u><u>\$103,333</u></u>	<u><u>\$ 51.67</u></u>

* *Computation of factory overhead:*

Total cost of goods sold = $(\$368,000 + \$192,000) \div 75\% = \$746,667$

Factory overhead = $\$746,667 \times 25\% = \$186,667$

(c)

*Englewood Company
Income Statement
Year 19X6 Revised*

	Total	Per Unit
Sales (2,000 units)	<u>\$920,000</u>	<u>\$460.00</u>
Cost of goods sold		
Materials	\$368,000	\$184.00
Labor	192,000	96.00
Factory overhead		
Fixed	\$125,000	\$62.50
Variable	<u>60,000*</u>	<u>30.00</u>
Total cost of sales	<u>\$745,000</u>	<u>\$372.50</u>
Gross profit	\$175,000	\$ 87.50
Selling and administrative expenses	<u>70,000</u>	<u>35.00</u>
Net profit	<u><u>\$105,000</u></u>	<u><u>\$ 52.50</u></u>

* The factory overhead in 19X5 was \$200,000, made up of \$125,000 fixed expense and \$75,000 variable expense. The variable expense per unit is \$30 ($\$75,000 \div 2,500$ units). The variable portion of factory overhead in 19X6, therefore, is 2,000 units times \$30, or \$60,000.

1.9 Cost of Goods Manufactured. The Hempstead Company, which manufactures a single product, shows the following ledger balances for the month of January, 19X6.

Direct labor	\$180,000
Indirect labor	65,000
Factory rent	11,000
Heat, light and power	3,500
Miscellaneous factory overhead	16,500
Interest expenses	4,500
Office salaries	11,000
Sales commissions	4,000
Sales returns and allowances	5,000
Freight-out	5,500

Other data:

Purchases of raw materials: 16,000 units at \$3.00 each: 10,000 units at \$2.50 each.

Production: 25,000 units.

Sales: 20,000 units at \$12.

Raw materials inventory, January 1: 2,000 units at \$3.50 each.

The first-in, first-out method is used in valuing raw materials inventory.

Each unit of finished goods requires one unit of raw material.

Work-in-process inventory: January 1, 3,000 units costing \$12,000: at January 31, 5,000 units costing \$17,000.

Finished goods inventory, January 1: 5,000 units at \$9 each.

Factory machinery: cost \$30,000, depreciation 10% per year.

Office equipment: cost \$10,000, depreciation 8% per year.

Prepare a Statement of Cost of Goods Manufactured for the month of January, 19X6.

SOLUTION

The Hempstead Company
Statement of Cost of Goods Manufactured
for month of January, 19X6

Raw materials

Inventory, January 1 \$ 7,000

Purchases 73,000

Raw materials available \$80,000

Less: Inventory, January 31* 7,500

Cost of raw materials used \$ 72,500

Direct labor 180,000

Factory overhead

Indirect labor \$65,000

Factory rent 11,000

Heat, light and power 3,500

Depreciation, machinery 250

Miscellaneous	<u>16,500</u>	<u>96,250</u>
Total manufacturing costs		\$348,750
Add: Work in process, January 1		<u>12,000</u>
Balance		\$360,750
Deduct: Work in process, January 31		<u>17,000</u>
Cost of goods manufactured		<u><u>\$343,750</u></u>

** Raw Materials Used*

Inventory, January 1	2,000
Purchases (16,000 + 10,000)	<u>26,000</u>
Units available	28,000
Used in production	<u>25,000</u>
Inventory, January 31	<u><u>3,000</u></u>

Chapter 2

Costing and Control of Materials and Labor

2.1 CHARACTERISTICS OF MATERIALS AND LABOR

Materials are the basic substances that are transformed into finished goods. Materials costs may be either *direct* or *indirect*.

Direct Materials. There are three characteristics of direct materials: (1) They are easily traced to the product.

- (2) They represent a major material of the finished product.
- (3) They can be identified directly with production of the product.

Indirect Materials. These include all other materials used in production (i.e., nails in furniture manufacturing) and are considered to be a factory overhead cost.

Labor is the physical and/or mental effort expended to manufacture products. *Labor cost* is the price paid for using human resources. Labor cost may be either *direct* or *indirect*.

Direct Labor. There are also three characteristics of direct labor: (1) It is easily traced to the product.

- (2) It is a major cost of producing the product.
- (3) It can be identified directly with production of the product.

Indirect Labor. This includes all other labor costs related to production (e.g., salary of plant supervisor). Like indirect materials, this is considered a factory overhead cost.

Materials

2.2 SYSTEMS OF ACCOUNTING FOR THE PURCHASE OF MATERIALS

There are two systems that may be used to account for the purchase of materials.

Under a *periodic inventory system*, the purchase of both direct and indirect materials is recorded in an account entitled Purchases of Raw Materials. If a beginning materials inventory exists, it is recorded in a separate account entitled Materials Inventory—Beginning.

Under a *perpetual inventory system*, the purchase of materials is recorded in an account labeled Materials Inventory, rather than in a purchases account. If a beginning materials inventory exists, it is already included in the materials inventory account.

In this book the journal entries were prepared under the perpetual cost accumulation system. Because of the use of computers for cost accumulation, the periodic system is rarely employed.

EXAMPLE 1

Construction Company receives 1,000 feet of tubing (direct) and 2 cases of assorted screws (indirect). The tubing is \$20 per foot and the screws are \$25 per case. The journal entry under the perpetual inventory system follows:

<i>Materials Inventory</i>	20,050	
<i>Accounts Payable</i>		20,050

2.3 ISSUANCE OF MATERIALS

- (1) A material requisition must be prepared by the production department requesting the goods. The requisition should contain the job order number and/or the name of department making the request, the quantity and description of the goods, and the unit and total costs.
- (2) Recording materials issued also differs, depending on whether a periodic or perpetual system is used. No entry is made under a periodic cost accumulation system when materials are issued; however, under a perpetual cost accumulation system, a debit is made to a work-in-process account and a credit is made to the materials inventory account.

EXAMPLE 2

Construction Company places 500 feet of tubing in production (\$20 per foot). The entry to record

this is:

<i>Work-in-Process Inventory</i>	10,000	
<i>Materials Inventory</i>		10,000

2.4 COSTING MATERIALS ISSUED AND ENDING MATERIALS INVENTORY

Under the perpetual inventory system, materials issued are charged to the work-in-process inventory account as they are used (see above). Thus, the ending materials inventory can be readily determined from the materials inventory account.

Periods of changing prices pose problems for the valuation of inventory. For example, what price should be charged for materials placed into production during such a period; what price should be charged for materials still on hand at the end of the period (ending materials inventory); and should the cost of materials issued be determined by the beginning unit price of materials, the average unit price for the period, or the ending unit price? Because the answers to these questions vary, four methods have been developed to value ending inventories and cost of materials issued during periods of changing prices: (1) Specific identification

(2) Average cost—simple and weighted

(3) First-in, first-out (FIFO)

(4) Last-in, first-out (LIFO)

Use of each method under both the periodic and the perpetual inventory systems is illustrated in [Examples 3 to 7](#). For convenience, BI and EI are used to denote Beginning Inventory and Ending Inventory, respectively. All these examples are based on the following data: Sweet Dreams

Company's inventory and purchases of brass tubing are as follows:

	Date	Units Purchased	Cost per Unit (\$ per ft)	Units Issued
(BI)	1/1	1,500	\$1.75	—
	1/7	1,000	1.80	—
	1/9	—	—	1,000 (from BI)
	1/15	—	—	500 (from BI)
	1/21	2,000	2.00	—
	1/25	500	2.10	—
	1/30	—	—	2,000 (from 1/7 & 1/21 purchase)

Ending Inventory 1/31: 1,500 units

- (1) **Specific Identification.** Under this method each item is placed into inventory with a price tag. Both ending inventory and materials issued are valued at the prices tagged on each unit. This technique is generally used for expensive items.

EXAMPLE 3

Periodic and Perpetual Inventory Systems

When specific identification is used, both the application of the technique and the results are *identical* under *either* the periodic or the perpetual inventory system, as illustrated below:

Cost of materials issued:

(BI)	1,000 × \$1.75 =	\$1,750
(BI)	500 × \$1.75 =	875
(1/7)	1,000 × \$1.80 =	1,800
(1/21)	1,000 × \$2.00 =	<u>2,000</u>
		<u><u>\$6,425</u></u>

Ending inventory:

(1/21)	1,000 × \$2.00 =	\$2,000
(1/25)	500 × \$2.10 =	<u>1,050</u>
		<u><u>\$3,050</u></u>

(2) **Average Cost.** This method is more appropriate for small, homogeneous items (i.e., brass tubing) and when specific identification is impossible (i.e., peanuts). There are two ways to compute average cost—simple average and weighted average.

(a) *Simple Average.* The *unit price* of the items in beginning inventory is added to the *unit price* of each purchase, and the sum is divided by the number of purchases plus one (for beginning inventory). This method is most accurate when purchases are of the same quantity. The object is to compute the average purchase (unit) price.

EXAMPLE 4

Periodic Inventory System

Because inventory and materials issued are not valued until the end of the period under periodic inventory systems, the average cost is calculated only once, at the end of the period.

$$\begin{aligned}\text{Simple average unit cost} &= \frac{\text{BI unit price} + \text{Unit price of each purchase}}{\text{Number of purchases} + 1 \text{ (for BI)}} \\ &= \frac{\$1.75 + \$1.80 + \$2.00 + \$2.10}{3 + 1} = \frac{\$7.65}{4} = \$1.9125\end{aligned}$$

$$\text{Cost of materials issued: } 3,500 \times \$1.9125 = \underline{\underline{\$6,693.75}}$$

$$\text{Ending inventory: } 1,500 \times \$1.9125 = \underline{\underline{\$2,868.75}}$$

Note: The actual cost of materials available differs from \$9,475 because of the unequal number of units purchased at each price.

Perpetual Inventory System

Under perpetual inventory systems an average must be calculated *each time* a purchase is made because a running inventory is being kept. Materials are issued at the last average cost at their date of issuance. This is called a *simple moving average*. See [Table 2-1](#).

Table 2-1 Simple Moving Average

Date	Purchases			Issued			Balance		
	Units	Unit Cost	Cost of Materials Avail. for Use	Units	Unit Cost	Cost of Materials Issued	Units	Unit Cost	Total Cost
(BI) 1/1	1,500	\$1.75	\$2,625	—	—	—	1,500	\$1.75	\$2,625.00
1/7	1,000	1.80	1,800	—	—	—	2,500	1.775(a)	4,437.50
1/9	—	—	—	1,000	\$1.775	\$1,775.00	1,500	1.775	2,662.50
1/15	—	—	—	500	1.775	887.50	1,000	1.775	1,775.00
1/21	2,000	2.00	4,000	—	—	—	3,000	1.85(b)	5,550.00
1/25	500	2.10	1,050	—	—	—	3,500	1.9125(c)	6,693.75
1/30	—	—	—	2,000	1.9125	<u>3,825.00</u>	1,500	1.9125	<u>\$2,868.75 (EI)</u>
			<u>\$9,475</u>			<u>\$6,487.50</u>			

Computations:

(a) $\frac{\$1.75 + \$1.80}{2} = \$1.775$

(b) $\frac{\$1.75 + \$1.80 + \$2.00}{3} = \1.85

(c) $\frac{\$1.75 + \$1.80 + \$2.00 + \$2.10}{4} = \$1.9125$

Cost of materials issued	\$6,487.50
Ending inventory	<u>2,868.75</u>
Actual cost of materials available	<u>\$9,356.25</u>

Note: The actual cost of materials available differs from \$9,475 (Table 2-1, column 4) because of

the unequal number of units purchased at each price. This problem is overcome by the weighted average method (Example 5).

(b) *Weighted Average*. This method overcomes the limitations of simple average by considering the purchase quantity as well as the price. Under this method each purchase (including beginning inventory) is calculated by multiplying the quantity purchased by the respective unit cost to get a total purchase cost. The purchase costs are summed and divided by the units of materials available for use. The implementation of this method differs depending on whether a periodic or perpetual system is under use.

EXAMPLE 5

Periodic Inventory System

Under a periodic system the weighted average is calculated only once, at the end of the period.

$$\begin{aligned} \text{Weighted average} &= \frac{\text{Total purchase cost}}{\text{Materials available for use}} \\ &= \frac{(1,500 \times \$1.75) + (1,000 \times \$1.80) + (2,000 \times \$2.00) + (500 \times \$2.10)}{5,000} = \$1.895 \end{aligned}$$

$$\text{Cost of materials issued: } 3,500 \times \$1.895 = \underline{\underline{\$6,632.50}}$$

$$\text{Ending inventory: } 1,500 \times \$1.895 = \underline{\underline{\$2,842.50}}$$

Perpetual Inventory System

Under a perpetual system an average is calculated at the time of each purchase (hence it is called a weighted *moving* average) and is used to issue materials until a new purchase is made, at which time the average cost must be recalculated. See Table 2-2.

Table 2-2 Weighted Moving Average

Date	Purchases			Issued			Balance		
	Units	Unit Cost	Cost of Materials Avail. for Use	Units	Unit Cost	Cost of Materials Issued	Units	Unit Cost	Total Cost
(BI) 1/1	1,500	\$1.75	\$2,625	—	—	—	1,500	\$1.75	\$2,625.00
1/7	1,000	1.80	1,800	—	—	—	2,500	1.77(a)	4,425.00
1/9	—	—	—	1,000	\$1.77	\$1,770.00	1,500	1.77	2,655.00
1/15	—	—	—	500	1.77	885.00	1,000	1.77	1,770.00
1/21	2,000	2.00	4,000	—	—	—	3,000	1.9233(b)	5,769.90
1/25	500	2.10	1,050	—	—	—	3,500	1.9485(c)	6,819.75
1/30	—	—	—	2,000	1.9485	3,897.00	1,500	1.9485	<u>\$2,922.75 (EI)</u>
			<u>\$9,475</u>			<u>\$6,552.00</u>			

Computations:

$$(a) \frac{(1,500 \times \$1.75) + (1,000 \times \$1.80)}{2,500} = \$1.77$$

$$(b) \frac{(1,000 \times \$1.77) + (2,000 \times \$2.00)}{3,000} = \$1.9233$$

$$(c) \frac{(3,000 \times \$1.9233) + (500 \times \$2.10)}{3,500} = \$1.9485$$

Cost of materials issued	\$6,552.00
Ending inventory	2,922.75
Rounding difference	0.25
Cost of materials available	<u>\$9,475.00</u>

(3) **FIFO (First-in, first-out)**. Materials issued for use under this method come from beginning inventory and then the earlier purchases. The ending inventory here is considered to be the last

materials purchased and therefore reflects current costs.

EXAMPLE 6

Periodic and Perpetual Inventory Systems

Both inventory systems yield identical results for materials issued and ending inventory when FIFO is used.

Cost of materials issued: The 3,500 units issued come from the earliest purchases, so we start with beginning inventory and work forward.

	Date	Units	Unit Cost (\$)	Cost of Materials Issued
(BI)	1/1	1,500	\$1.75	\$2,625
	1/7	1,000	1.80	1,800
	1/21	<u>1,000</u>	2.00	<u>2,000</u>
		<u><u>3,500</u></u>		<u><u>\$6,425</u></u>

Ending inventory: To get the ending inventory we start with the last purchase and work backward.

Date	Units	Unit Cost (\$)	Total
1/25	500	\$2.10	\$1,050
1/21	<u>1,000</u>	2.00	<u>2,000</u>
	<u><u>1,500</u></u>		<u><u>\$3,050</u></u> E1
Cost of materials available: \$6,425 + \$3,050 = <u><u>\$9,475</u></u>			

(4) **LIFO (Last-in, first-out)**. Under this method we assume that the last goods received will be the first issued (exactly the opposite of FIFO). Therefore, our ending inventory will include the period's beginning inventory and the early purchases. Results of LIFO application differ, depending on whether a periodic or perpetual system is used.

EXAMPLE 7

Periodic Inventory System

The calculation of materials issued and ending inventory is done at the end of the period, as is normal with periodic systems.

Cost of materials issued: To value the 3,500 units issued, we begin with the last purchase and work backward.

Date	Units	Unit Cost (\$)	Cost of Materials Issued
1/25	500	\$2.10	\$1,050
1/21	2,000	2.00	4,000
1/7	<u>1,000</u>	1.80	<u>1,800</u>
	<u><u>3,500</u></u>		<u><u>\$6,850</u></u>

Ending inventory: To arrive at a value for the ending inventory, we begin with the beginning inventory and work forward.

Date	Units	Unit Cost (\$)	Total
(BI) 1/1	<u>1,500</u>	\$1.75	<u>\$2,625</u> EI

Cost of materials available: $\$6,850 + \$2,625 = \underline{\underline{\$9,475}}$

Perpetual Inventory System

The ending inventory and the value of materials issued will differ from those calculated under a periodic system because costs are assigned as materials are issued and *not* at the end of the period. Our ending inventory value will be greater here for this reason.

Table 2-3 LIFO in Perpetual Inventory System

Date	Purchases			Issued			Balance		
	Units	Unit Cost	Cost of Materials Avail. for Use	Units	Unit Cost	Cost of Materials Issued	Units	Unit Cost	Total Cost
(BI) 1/1	1,500	\$1.75	\$2,625	—	—	—	1,500	\$1.75	\$2,625
1/7	1,000	1.80	1,800	—	—	—	2,500	(a)	4,425
1/9	—	—	—	1,000	\$1.80	\$1,800	1,500	1.75	2,625
1/15	—	—	—	500	1.75	875	1,000	1.75	1,750
1/21	2,000	2.00	4,000	—	—	—	3,000	(b)	5,750
1/25	500	2.10	1,050	—	—	—	3,500	(c)	6,800
1/30	—	—	—	2,000	(e)	<u>4,050</u>	1,500	(d)	<u>\$2,750(EI)</u>
			<u>\$9,475</u>			<u>\$6,725</u>			

Computations:

- (a) $(1,500 \times \$1.75) + (1,000 \times \$1.80) = \$4,425$
(b) $(1,000 \times \$1.75) + (2,000 \times \$2.00) = \$5,750$
(c) $(1,000 \times \$1.75) + (2,000 \times \$2.00) + (500 \times \$2.10) = \$6,800$
(d) $(1,000 \times \$1.75) + (500 \times \$2.00) = \$2,750$
(e) $(500 \times \$2.10) + (1,500 \times \$2.00) = \$4,050$

Cost of materials issued	\$6,725
Ending inventory	<u>2,750</u>
Cost of materials available	<u>\$9,475</u>

2.5 COMPARISON OF INVENTORY METHODS

The method selected determines the values of materials issued and ending inventory. The inventory system used also has an effect on these values. A firm should select its method of inventory valuation carefully since the *principle of consistency* states that the method chosen should be adhered to each period. A change can be made only if it can be shown that doing so would improve the accuracy of the firm's financial statements.

2.6 LOWER OF COST OR MARKET (LCM)

LCM is a rule which states that inventory should be valued at the lower of its historical cost (time of purchase) or current market value (usually replacement cost).

- (1) Generally, in inflationary times, historical cost is lower than market, so no adjustment is necessary.
- (2) If market is lower than cost, the ending inventory must be reported at market. This is based on the *principle of conservatism*, which requires applying the accounting treatment that results in the lowest estimate of assets and income for the current period.
- (3) If inventory is reduced under LCM, the resulting loss is generally added to the cost of goods manufactured.

LCM can be computed two ways:

- (1) Applied to the total inventory value
- (2) Applied on an item-by-item basis to ending inventory

EXAMPLE 8

Using the ending inventory calculated under LIFO (perpetual) in [Example 7](#), assume the replacement cost of brass tubing decreased to \$1.80 per foot.

(a) LCM applied to the total inventory value:

	Date	Units	Unit Cost (\$)	Total
(BI)	1/1	1,000	\$1.75	\$1,750
	1/21	<u>500</u>	2.00	<u>1,000</u>
		<u>1,500</u>		<u>\$2,750</u>

Applying LCM to ending inventory, we get $1,500 \times \$1.80 = \$2,700$.

Ending inventory before LCM adjustment	\$2,750
Ending inventory after LCM adjustment	<u>2,700</u>
Loss (to be added to Cost of Goods Manufactured)	<u><u>\$ 50</u></u>

(b) LCM applied item-by-item to ending inventory:

	Date	Units	Unit Cost (\$)	Replacement Cost		Adjusted Total
(BI)	1/1	1,000	\$1.75	\$1.80	(1,000 × 1.75)	\$1,750
	1/21	<u>500</u>	2.00	1.80	(500 × 1.80)	<u>900</u>
		<u>1,500</u>				<u><u>\$2,650</u></u>
						Ending inventory before LCM adjustment \$2,750
						Ending inventory after LCM adjustment <u>2,650</u>
						Loss (to be added to Cost of Goods Manufactured) <u><u>\$ 100</u></u>

Note: The application of LCM on an item-by-item basis results in the *most conservative* ending inventory value.

Note: The application of LCM on an item-by-item basis results in the *most conservative* ending inventory value.

There are several criticisms of LCM:

- (1) It violates the principle of consistency because inventories may be valued one way at one time and another way at another time.
- (2) It is also inconsistent because the technique recognizes losses in inventory value before inventory is sold but doesn't recognize increases in replacement cost until goods are sold.

2.7 CONTROL PROCEDURES

Because inventory represents a major investment to a firm, adequate control is essential. The level of raw materials inventory is based on scheduled production, which is in turn based on sales forecasts. Four control procedures are commonly used: (1) **Order cycling**. Materials are reviewed on a regular cycle, and orders are placed to maintain a desired inventory level.

- (2) **Min-max method**. Minimum and maximum inventory levels are determined. Goods are reordered when the minimum level is reached.
- (3) **Two-bin method**. This is used for inexpensive items. When the first bin is empty, an order is placed. The second bin provides coverage until the order is received.
- (4) **Automatic order system**. An order is automatically placed when the inventory reaches a predetermined level. This system works best when a computer is used to keep track of inventory, ordering, *etc.*

In addition to the four control procedures, the *ABC plan* is used by many companies to monitor inventory levels. The inventory is separated into three categories. Category A represents the most expensive items, which require the most careful monitoring, and would utilize a method such as order cycling. Category B items are moderate in price and quantity. The min-max method is appropriate in this case. Category C items are inexpensive and kept in large quantities. The two-bin method may be used for these items. In each of these categories, the automatic order system is useful in companies that employ computers.

Labor

2.8 LABOR COSTS

Labor costs usually represent a significant cost of production and are steadily increasing in proportion to other costs. Much of the increase is due to fringe benefits such as vacations, insurance, bonuses, *etc.*, included in an employee's compensation. The single major component of employee compensation is usually the wage or salary.

Wages are payments made on an hourly, daily, or piecework basis, whereas *salaries* are fixed payments for managerial services. Other terms necessary for any discussion of labor costs are best defined by equations, as follows: $Gross\ earnings = Regular\ wages + Overtime\ premium$
 $Regular\ wage = Total\ hours\ worked\ (including\ overtime) \times Regular\ hourly\ rate$
 $Overtime\ premium = Overtime\ hours\ worked \times Extra\ hourly\ compensation\ for\ overtime$

2.9 OVERTIME AND SHIFT PREMIUM

Overtime Premium

The additional compensation paid for overtime is separated from regular wages and charged to factory overhead. The effect of this is to charge all units produced with the same rate of labor (regular rate).

EXAMPLE 9

An employee worked 45 hours this week. His regular wage is \$10.00 per hour, and he is paid time and a half for overtime hours (i.e., hours beyond 40 per week).

Regular wage = \$10.00/hour

Overtime wage = \$15.00/hour

Overtime premium = \$5.00/hour

<i>Work-in-Process Inventory</i>	450*	
<i>Factory Overhead Control—Overtime Premium</i>	25**	
<i>Payroll Payable</i>		475

* 45 hours × \$10.00

** 5 hours × \$5.00

Note: As with direct materials, direct labor is charged to work-in-process inventory as incurred under a perpetual cost accumulation system. All additional compensation (above regular wage rates) is charged to *one* account, called Factory Overhead Control.

Shift Premium or Differential

Often an above-normal wage is paid for undesirable shifts (e.g., night shifts). Like the overtime premium, this *extra* portion is charged to factory overhead.

EXAMPLE 10

Employees who work days are paid \$5.00 per hour. Those who work nights are paid \$5.50 per hour. All employees work 40 hours per week. Record the weekly wages for one night employee.

Regular wage = \$5.00/hour

Night wage = \$5.50/hour

Shift premium = \$0.50/hour

<i>Work-in-Process Inventory</i>	200*	
<i>Factory Overhead Control—Shift Premium</i>	20**	
<i>Payroll Payable</i>		220

* 40 hours × \$5.00

** 40 hours × \$0.50

2.10 BONUS

A bonus is additional compensation generally given in recognition of exceptional productivity. Bonuses may be a set amount, a percentage of profits, or a percentage of an employee's salary. Theoretically, a bonus is a direct cost of production. However, because the purpose of cost accumulation is the establishment of a standard unit cost, bonuses are charged to factory overhead. Ideally, a bonus should be charged to a liability each week the eligible employee works. In practice this can rarely be done, so a single entry at the end of the period is made.

EXAMPLE 11

Each of ABC's employees is entitled to receive a bonus of 1% of the company's prior year's profits. Record the weekly payroll of one assembly-line employee, including accrual of the bonus, if weekly pay is \$500. Assume that profits for the prior year were \$260,000. The entry is:

<i>Work-in-Process Inventory</i>	500	
<i>Factory Overhead Control—Bonuses</i>	50*	
<i>Bonuses Payable</i>		50
<i>Payroll Payable</i>		500

* \$260,000 × 1% = \$2,600

\$2,600 ÷ 52 weeks = \$50

2.11 VACATION AND HOLIDAY PAY

After a certain length of service, an employee generally receives paid vacations and holidays. Compensation of this sort is called nonproductive pay because an employee is receiving wages while making no contribution to output. Vacation and holiday pay are charged to factory overhead. As a result, we are able to charge each week of service equally with a portion of vacation pay.

EXAMPLE 12

Marlene has worked for the Long Life Battery Company for five years and is therefore entitled to two weeks paid vacation. Her weekly pay is \$500. Make the entry to accrue Marlene's vacation pay for the week, assuming she is not on vacation now.

Total vacation pay: \$500 per week \times 2 weeks = \$1,000

Weeks over which vacation pay is to be accrued: 52 weeks $-$ 2-week vacation = 50 weeks

Weekly accrual: \$1,000 \div 50 weeks = \$20 per week

<i>Work-in-Process Inventory</i>	<i>500</i>	
<i>Factory Overhead Control—Vacation Pay</i>	<i>20</i>	
<i>Vacation Pay Payable</i>		<i>20</i>
<i>Payroll Payable</i>		<i>500</i>

Some major points to remember about paid holidays and vacations are:

- (1) Like vacations, the number of company paid holidays is subject to policy and known in advance. These two are often combined in one account called Vacation and Holiday Pay and accrued together.
- (2) Vacations are often taken in the summer, so any necessary corrections in the accruals can be spread over the remainder of the year. In reality, employees leave or are hired or terminated, so adjustments are continually required. Many companies charge off vacation and holiday pay monthly to reduce the number of entries.
- (3) For salaried employees, vacation and holiday pay is charged to the period when the absence occurs rather than being accrued.

2.12 PENSIONS

Pension accounting is a separate field in itself due to the complex nature and enormous expense of pension plans. Actuaries, experts in life expectancies, determine a company's pension costs through a series of complicated formulas. To arrive at a cost for a pension plan, the following factors must be considered: (1) Number of employees retiring each year.

- (2) Amount of benefits paid to each retired employee.
- (3) Length of time that benefits will be paid.

- (4) Amount of income earned from pension fund investments.
- (5) Amount of administrative expenses.
- (6) Benefits for employees who leave before retirement age.

After pension costs have been established, those costs associated with production employees are debited to factory overhead control.

2.13 FRINGE COSTS

Wages and salaries plus any fringe benefits constitute the employer's payroll expense. Vacation pay and pension plans are only two of a number of employee benefits. Other common fringe costs are listed below.

- (1) ***Federal Insurance Contribution Act (FICA)***, also known as the ***Social Security Act***. Employees *and* employers contribute *equal* percentages based on employee wages.
- (2) ***Federal Unemployment Tax Act (FUTA)***. This tax is paid *only* by employers as a percentage of employee wages.
- (3) ***State Unemployment Tax Act (SUTA)***. This tax is also a percentage based on employee wages and generally is fully paid by the employer.
- (4) ***State Workers' Compensation***. Again, a percentage based on employee wages is contributed by the employer. Rates vary depending on occupational hazards.
- (5) ***Other***. There are also a variety of optional plans an employer may provide, such as health or life insurance. Often the cost of these plans is shared by the employee.

The majority of companies treat the expenses of fringe costs as charges to factory overhead.

Incentive Plans

Some companies adopt incentive plans to encourage increases in production. Employees are not penalized for producing less than the specified amount but are paid extra for producing more. Wages paid but not earned on a piecework basis are charged to factory overhead.

EXAMPLE 13

Muffler Ltd. manufactures scarves. The average salary is \$200 per week. To increase production, the company adopted an incentive plan. The piecework rate per scarf is \$1.00. Any employee who produces fewer than 200 scarves per week will still receive his or her original pay. Production above this amount will earn the employee \$1.00 for each additional scarf. One week after the plan was implemented, the following data were collected:

Employee	Scarves Produced	Wages Paid
----------	------------------	------------

Bob	200	\$200
Carol	215	215
Ted	190	200
Alice	205	205

Bob: 200 scarves × \$1 per unit = \$200	No adjustment necessary		
Carol: 215 scarves × \$1 per unit = \$215	Entire amount is direct labor		
Ted: 190 scarves × \$1 per unit = \$190	<table border="1"> <tr> <td>\$190 is direct labor</td> </tr> <tr> <td>\$10 is charged to factory overhead control</td> </tr> </table>	\$190 is direct labor	\$10 is charged to factory overhead control
\$190 is direct labor			
\$10 is charged to factory overhead control			
Alice: 205 scarves × \$1 per unit = \$205	Entire amount is direct labor		

Provided a unit is produced for each wage increment, the entire amount is considered direct labor. When an employee is paid for *more* than he or she actually produces, the difference is charged to factory overhead to avoid distorting the unit cost.

Note: Since in theory no single unit is any more expensive to produce than any other, all additional compensation above regular wage rates and all nonproductive pay are charged to factory overhead. This is then distributed over all units produced.

2.14 ACCOUNTING FOR LABOR

Three activities are involved in accounting for labor: (1) timekeeping, (2) computation of total payroll, and (3) allocation of payroll cost.

(1) **Timekeeping.** In a manufacturing concern, two forms of timekeeping are commonly used.

(a) *Time card.* This is used for punching a time clock to record all hours spent at work.

(b) *Labor job ticket.* This is a record prepared by an employee showing how the hours at work were spent (i.e. jobs that were worked on and hours spent on each). Any time *not* allocated to a particular job is charged to factory overhead.

- (2) **Computing Total Payroll.** The function of determining each employee's pay, taking the appropriate deductions, and issuing the pay checks is generally done by the payroll department.
- (3) **Allocating Payroll Costs.** This function is generally performed by the cost accounting department. The total payroll expense, including fringe costs, is allocated to particular jobs or departments. The *entire* payroll cost must be allocated.

Journalizing Payroll

Once the preceding three steps have been completed, the payroll is entered into a journal. The basic journal entries to record factory labor costs are as follows: (1) *To record the payroll:*

<i>Work-in-Process Inventory (direct labor)</i>	<i>X</i>	
<i>Factory Overhead Control (indirect labor)</i>	<i>X</i>	
<i>Payroll Payable</i>		<i>X</i>

- (2) *To record employee withholdings* and pay the payroll:*

<i>Payroll Payable</i>	<i>X</i>	
<i>Employee Withholdings Payable</i>		<i>X</i>
<i>Cash (to employees)</i>		<i>X</i>

* These withholdings include FICA, state and federal taxes, union dues, insurance, savings, etc.

- (3) *To record employer taxes and fringe benefit costs (pensions, insurance, etc.):*

<i>Factory Overhead Control</i>	<i>X</i>	
<i>Employer Taxes and Benefits Payable</i>		<i>X</i>

In addition to accounting for employee payroll taxes (FICA and federal and state withholdings), employers are required to account for and pay certain employer payroll taxes, such as an amount equal to the FICA tax withheld from each employee's salary, and federal and state unemployment taxes. Employees are not responsible for paying unemployment taxes. In addition, many employers contribute to a pension plan for the benefit of employees.

In the examples in this book we will assume the following tax rates and fringe benefit contributions: *FICA*: 7% paid by employer AND employee

Federal unemployment taxes (FUTA): 0.8%

State unemployment taxes (SUTA): 4%

Pension fund contribution: 5%

Using the data above and the following payroll information, prepare the journal entries to (1) record the payroll, (2) record employee taxes and pay the payroll, and (3) record employer taxes and fringe benefit cost.

Direct labor	\$40,000	Federal and state income	
Indirect labor	15,000	taxes payable	\$4,500

(1) To record the payroll:

<i>Work-in-Process Inventory</i>	40,000	
<i>Factory Overhead Control</i>	15,000	
<i>Payroll Payable</i>		55,000

(2) To record employee taxes and pay the payroll:

<i>Payroll Payable</i>	55,000	
<i>Employee Income Taxes Payable</i>		4,500
<i>Employee FICA Taxes Payable</i>		3,850*
<i>Cash</i>		46,650

* \$55,000 × 7%

(3) To record employer taxes and fringe benefits:

<i>Factory Overhead Control</i>	9,240(a)	
<i>Employer FICA Taxes Payable</i>		3,850(b)
<i>Employer FUTA Taxes Payable</i>		440(c)
<i>Employer SUTA Taxes Payable</i>		2,200(d)
<i>Employer Pension Fund Payable</i>		2,750(e)

Computations:

(a)	
FICA tax rate	7.0%
FUTA tax rate	.8%
SUTA tax rate	4.0%
Pension contribution	<u>5.0%</u>
Total	<u>16.8%</u> × \$55,000 = \$9,240

(b) $\$55,000 \times 7\% = \$3,850$

(c) $\$55,000 \times 0.8\% = \$ 440$

(d) $\$55,000 \times 4\% = \$2,200$

(e) $\$55,000 \times 5\% = \$2,750$

Solved Problems

2.1 Tepee Ltd., a tent manufacturer, recorded the following transactions for the month of May:

	Date	Units Purchased	Unit Cost (\$)	Units Issued
(BI)	5/1	10	\$15	—
	5/5	20	20	—
	5/15	—	—	15
	5/19	—	—	10
	5/24	15	18	—
	5/30	—	—	15

Assume the company uses a periodic inventory system and compute the ending materials inventory and cost of materials issued under (a) specific identification (materials issued on 5/15 came from the 5/5 purchase, materials issued on 5/19 came from beginning inventory, and those issued on 5/30 came from the 5/5 and 5/24 purchases); (b) weighted average cost; (c) FIFO; (d) LIFO.

SOLUTION

(a) **Specific identification**

Date of Issue	Purchase Lot	Units × Cost	Cost of Materials Issued
5/15	5/5	15 × \$20	= \$300
5/19	BI	10 × \$15	= 150
5/30	5/5 & 5/24	(5 × \$20) + (10 × \$18)	= <u>280</u>
			<u><u>\$730</u></u>

Ending inventory: 5 (from 5/24 purchase) × \$18 = \$90

(b) **Weighted average cost**

$$\frac{(10 \times \$15) + (20 \times \$20) + (15 \times \$18)}{45} = \$18.222$$

$$\text{Cost of materials issued: } 40 \times \$18.222 = \underline{\underline{\$728.88}}$$

$$\text{Ending inventory: } 5 \times \$18.222 = \underline{\underline{\$91.11}}$$

(c) **FIFO**

Date	Units	Unit Cost (\$)	Cost of Materials Issued
BI	10	\$15	\$150
5/5	20	20	400
5/24	<u>10</u>	18	<u>180</u>
	<u>40</u>		<u>\$730</u>

Ending inventory: $5 \times \$18 = \90

(d) LIFO

Date	Units	Unit Cost (\$)	Cost of Materials Issued
5/24	15	\$18	\$270
5/5	20	20	400
BI	<u>5</u>	15	<u>75</u>
	<u>40</u>		<u>\$745</u>

Ending inventory: $5 \text{ (from BI)} \times \$15 = \underline{\underline{\$75}}$

2.2 Assume the same set of facts as presented in Problem 2.1 except that Tepee Ltd. now uses a perpetual inventory system. Compute the cost of materials issued and ending inventory under (a) specific identification, (b) weighted average cost, (c) FIFO, and (d) LIFO.

SOLUTION

(a) Specific identification

The solution is the same as for Problem 2.1(a).

(b) Weighted (moving) average cost

Purchases			Issued			Balance		
Date	Units	Unit Cost (\$)	Units	Unit Cost (\$)	Cost of Materials Issued	Units	Unit Cost (\$)	Total Cost
(BI) 5/1	10	\$15	—	—	—	10	\$15.000	\$150.00
5/5	20	20	—	—	—	30	18.333(a)	550.00
5/15	—	—	15	\$18.333	\$275.00	15	18.333	275.00
5/19	—	—	10	18.333	183.33	5	18.333	91.67
5/24	15	18	—	—	—	20	18.083(b)	361.66
5/30	—	—	15	18.083	<u>271.25</u>	5	18.083	<u>90.42</u> EI
					<u>\$729.58</u>			

Computations:

$$(a) \frac{(10 \times \$15) + (20 \times \$20)}{30} = \$18.333$$

$$(b) \frac{(5 \times \$18.333) + (15 \times \$18)}{20} = \$18.083$$

(c) **FIFO**. The solution is the same as for Problem 2.1(c).

(d) **LIFO**

Purchases			Issued			Balance		
Date	Units	Unit Cost \$	Units	Unit Cost \$	Cost of Materials Issued	Units	Unit Cost \$	Total
(BI) 5/1	10	\$15	—	—	—	10	\$15	\$150
5/5	20	20	—	—	—	30	(a)	550
5/15	—	—	15	\$20	\$300	15	(b)	250
5/19	—	—	10	(c)	175	5	15	75
5/24	15	18	—	—	—	20	(d)	345
5/30	—	—	15	18	<u>270</u>	5	15	<u>\$ 75</u> EI
					<u>\$745</u>			

Computations:

(a) $(10 \times \$15) + (20 \times \$20) = \$550$

(b) $(10 \times \$15) + (5 \times \$20) = \$250$

(c) $(5 \times \$20) + (5 \times \$15) = \$175$

(d) $(5 \times \$15) + (15 \times \$18) = \$345$

2.3 The Rainy Day Pool Company is preparing for the upcoming season. The following data relate to the company's inventory of pool liners for the month of March:

(BI)	3/1	1,000 liners at \$100 ea.
	3/4	Purchased 1,500 at \$90 ea.
	3/10	Issued 1,200 liners
	3/16	Issued 800 liners
	3/20	Purchased 2,000 liners at \$75 ea.
	3/25	Issued 1,000 liners
	3/28	Issued 900 liners
	3/30	Purchased 1,000 liners at \$110 ea.

Prepare the journal entries to record these transactions under the perpetual inventory system. The company uses the LIFO method to record inventory.

SOLUTION

3/4	Materials Inventory (1,500 × \$90)	135,000	
	Cash		135,000
3/10	Work-in-Process Inventory (1,200 × \$90)	108,000	
	Materials Inventory		108,000
3/16	Work-in-Process Inventory (300 × \$90) + (500 × \$100)	77,000	
	Materials Inventory		77,000
3/20	Materials Inventory (2,000 × \$75)	150,000	
	Cash		150,000
3/25	Work-in-Process Inventory (1,000 × \$75)	75,000	
	Materials Inventory		75,000
3/28	Work-in-Process Inventory (900 × \$75)	67,500	
	Materials Inventory		67,500
3/30	Materials Inventory (1,000 × \$110)	110,000	
	Cash		110,000

2.4 The following information relates to the ending inventory of the Four Seasons Coat Company.

Materials	Quantity	Cost per Unit	Replacement Cost
Sleeves	50	\$2.00	\$1.95
Collars	32	1.50	1.60
Linings	25	2.50	2.25
Belts	41	1.75	1.80

(a) Compute the ending inventory before any LCM adjustment. Apply the LCM rule to the inventory (b) as a whole and (c) on an item-by-item basis.

SOLUTION

(a) Before LCM adjustment

Materials	Quantity		Cost per Unit		Total Cost
Sleeves	50	×	2.00	=	\$100.00
Collars	32	×	1.50	=	48.00
Linings	25	×	2.50	=	62.50
Belts	41	×	1.75	=	<u>71.75</u>
					<u><u>\$282.25</u></u> EI

(b) LCM applied to inventory in total

Materials	Quantity		Replacement Cost		Total Replacement Cost
Sleeves	50	×	\$1.95	=	\$ 97.50
Collars	32	×	1.60	=	51.20
Linings	25	×	2.25	=	56.25
Belts	41	×	1.80	=	<u>73.80</u>
					<u><u>\$278.75</u></u>
					Ending inventory before LCM adjustment
					\$282.25
					Ending inventory after LCM adjustment
					<u>278.75</u>
					Loss (to be entered in Cost of Goods Manufactured)
					<u><u>\$ 3.50</u></u>

(c) LCM applied to inventory item-by-item

Materials	Quantity		Lower of Cost or Replacement Cost		Total
Sleeves	50	×	\$1.95	=	\$ 97.50
Collars	32	×	1.50	=	48.00
Linings	25	×	2.25	=	56.25
Belts	41	×	1.75	=	<u>71.75</u>
					<u><u>\$273.50</u></u>

Ending inventory before LCM adjustment	\$282.25
Ending inventory after LCM adjustment	<u>273.50</u>
Loss (to be entered in Cost of Goods Manufactured)	<u><u>\$ 8.75</u></u>

2.5 Dippin' Donuts has six bakers and a bakery supervisor on each of its two shifts. Bakers working from 8 a.m.-5 p.m. (with a 1-hour break) are paid \$6.00 per hour. Bakers working the 10 p.m.-7 a.m. shift (with a 1-hour break) are paid \$6.75 per hour. The supervisors are paid a salary of \$300 per week. Due to the large volume of business, two of the daytime bakers worked until 8 p.m. three evenings this week; they both received time and a half for the extra hours worked. Prepare journal entries to distribute the weekly payroll.

SOLUTION

Day Shift

Wages: $\$6/\text{hour} \times 40 \text{ hours/week} = \$240/\text{week}$ for each baker
 $6 \text{ bakers} \times \$240/\text{week} = \$1,440/\text{week}$ for all bakers (direct labor)

Overtime: $(\$6/\text{hour} \times 3 \text{ hours/evening}) \times 2 \text{ bakers} = \$36/\text{evening} \times 3 \text{ evenings}$
 $= \$108$ (direct labor)

Overtime premium: $(\$3/\text{hour} \times 3 \text{ hours/evening}) \times 2 \text{ bakers} = \$18/\text{evening} \times 3 \text{ evenings}$
 $= \$54$ (overtime premium)

Night Shift

Wages: $\$6/\text{hour} \times 40 \text{ hours/week} = \$240/\text{week}$ for each baker
 $6 \text{ bakers} \times \$240/\text{week} = \$1,440/\text{week}$ for all bakers (direct labor)

Shift premium: $\$0.75/\text{hour} \times 40 \text{ hours/week} = \$30/\text{week}$ for each baker
 $6 \text{ bakers} \times \$30/\text{week} = \$180/\text{week}$ for all bakers (shift premium)

Supervisors

Salary: $\$300/\text{week} \times 2 \text{ supervisors} = \$600/\text{week}$, both supervisors (indirect labor)

Distribution

	Days	Nights
Direct labor:	$(\$1,440 + \$108) + \$1,440 = \$2,988$	
Overtime premium:	\$54	
Shift premium:		\$180
Indirect labor:	\$600	

<i>Work-in-Process Inventory</i>	2,988	
<i>Factory Overhead Control</i>	834	
<i>Payroll Payable</i>		3,822

Shift premium, overtime premium, and indirect labor are all elements of factory overhead. Under a perpetual system, these are all posted to one control account. A *control account* is a master balance for a subsidiary ledger. The reason the Factory Overhead Control account appears with subtitles earlier in this chapter (e.g., Factory Overhead Control—Shift Premium) is to denote the account in the *subsidiary ledger* in which the entry is made. It does not mean that separate Factory Overhead Control accounts appear in the general ledger.

- 2.6** The Lion's Den fur coat factory has a bonus plan with the following structure: (a) The fur cleaners (direct labor) receive one week's salary as a bonus at year-end. There are 20 workers in this category; each earns \$273 per week.
- (b) The tailors (direct labor) are paid 5% of their yearly salary as a bonus at year-end. The company has 10 tailors, each making \$350 per week.

Prepare separate journal entries to accrue the bonuses each week for each of the above categories of employees and distribute the weekly payroll in the same entry. Assume the company uses a perpetual cost accumulation system.

SOLUTION

(a)	<i>Work-in-Process Inventory</i> ($\$273 \times 20$)	5,460	
	<i>Factory Overhead Control—Bonus</i>	105*	
	<i>Bonus Payable</i>		105
	<i>Payroll Payable</i>		5,460

* $\$273 \div 52 \text{ weeks} = \$5.25 \times 20 \text{ fur cleaners} = \105

(b)	<i>Work-in-Process Inventory</i> ($\$350 \times 10$)	3,500	
	<i>Factory Overhead Control—Bonus</i>	175*	
	<i>Bonus Payable</i>		175
	<i>Payroll Payable</i>		3,500

* $\$350/\text{week} \times 5\% = \$17.50 \times 10 \text{ tailors} = \175

2.7 The Billings Industrial Supply Corporation has the following vacation policy:

1 to 3 years of service:	1 week paid vacation
4 to 7 years of service:	2 weeks paid vacation
8 to 10 years of service:	3 weeks paid vacation
Over 10 years of service:	4 weeks paid vacation

Examination of the payroll data on the company's 10 assembly line workers revealed the following:

Name	Years of Service	Weekly Salary
J. Adams	5	\$210
O. White	10	355
A. McFinny	6	250
F. Vasquez	8	300
R. Rubin	12	390
E. Cheshire	1/2	150
K. Quentin	4	190
D. Mancini	2	175
L. Johnson	15	425
Y. Flynn	1	160

(a) Determine the weekly accrual for each employee.

(b) Prepare the journal entry to distribute the payroll and accrue the vacation pay.

SOLUTION

(a)

Name	Weeks of Vacation	Total Vacation Pay	Weekly Accrual*
J. Adams	2	\$ 420	\$ 8.40
O. White	3	1,065	21.73
A. McFinny	2	500	10.00
F. Vasquez	3	900	18.37
R. Rubin	4	1,560	32.50
E. Cheshire	0	0	0
K. Quentin	2	380	7.60
D. Mancini	1	175	3.43
L. Johnson	4	1,700	35.42
Y. Flynn	1	160	3.14
			<u>140.59</u>

* Total vacation pay/[52 weeks - week(s) of vacation due]

(b)	<i>Work-in-Process Inventory</i>	2,605.00	
	<i>Factory Overhead Control—Vacation Pay</i>	140.59	
	<i>Vacation Pay Payable</i>		140.59
	<i>Payroll Payable</i>		2,605.00

2.8 Payroll is being prepared at Morgan Manufacturing, Inc. Examination of the labor job tickets for the week ending August 20 produced the following data:

Labor Hours

Employee	Hourly Wage	Labor Hours	
		Direct	Indirect
Howard	\$4.50	32	8
Peabody	5.25	38	2
Lancer	4.25	29	11
Cahill	4.30	40	0
Barnes	5.05	34	6
Williams	4.75	39	1
Thomas	4.90	28	12
Greene	5.15	36	4
Total FICA (employee)			\$102.24
Total FICA (employer)			102.24
Total Federal and State Income Tax			350.26
Federal Unemployment Tax (FUTA)			10.68
State Unemployment Tax (SUTA)			41.20

Prepare journal entries for a periodic cost accumulation system to (a) record payroll, (b) record employee taxes and payment of payroll, and (c) record the employer's payroll taxes.

SOLUTION

Payroll

Employee	Hourly Wage	Direct Labor	Indirect Labor	Total
Howard	\$4.50	(32 hr) \$ 144.00	(8 hr) \$ 36.00	\$ 180.00
Peabody	5.25	(38 hr) 199.50	(2 hr) 10.50	210.00
Lancer	4.25	(29 hr) 123.25	(11 hr) 46.75	170.00
Cahill	4.30	(40 hr) 172.00	(0) 0	172.00
Barnes	5.05	(34 hr) 171.70	(6 hr) 30.30	202.00
Williams	4.75	(39 hr) 185.25	(1 hr) 4.75	190.00
Thomas	4.90	(28 hr) 137.20	(12 hr) 58.80	196.00
Greene	5.15	(36 hr) 185.40	(4 hr) 20.60	206.00
		<u>\$1,318.30</u>	<u>\$207.70</u>	<u>\$1,526.00</u>

(a)	<i>Work-in-Process Inventory</i>	1,318.30	
	<i>Factory Overhead Control</i>	207.70	
	<i>Payroll Payable</i>		1,526.00
(b)	<i>Payroll Payable</i>	1,526.00	
	<i>Employee FICA Payable</i>		102.24
	<i>Employee Income Taxes Payable</i>		350.26
	<i>Cash</i>		1,073.50

(c)	<i>Factory Overhead Control</i>	154.12	
	<i>Employer FICA Payable</i>		102.24
	<i>Employer FUTA Payable</i>		10.68
	<i>Employer SUTA Payable</i>		41.20

Chapter 3

Factory Overhead and the Factory Ledger

3.1 FACTORY OVERHEAD DEFINED

The cost of direct labor and direct materials can easily be identified and charged to specific jobs. All other costs, such as indirect materials, indirect labor, and other factory expenses which cannot be identified with or charged directly to specific jobs, are called *factory overhead*. These *indirect* costs are categorized below.

Variable Costs. Total costs that vary in direct proportion to production volume are called variable overhead costs. If 20 gallons of glue are needed to produce 100,000 units and 40 gallons of glue are needed to produce 200,000 units, glue is considered a variable cost.

Fixed Costs. Total costs that do not vary in proportion to production volume within a relevant range are called fixed overhead. Rent is one example. Whether 100 or 1,000 units are produced, the rent for the use of a factory remains the same.

At the same time, fixed overhead *per unit* varies with production. If rent were \$10,000 a year and 100,000 units were produced in a year, rent per unit would be \$0.10. If 200,000 units were produced in a year, rent per unit would be only \$0.05.

Semivariable Costs. Total costs that will change, but *not in direct proportion* to production volume. An example of this would be factory utilities which often are comprised of a basic fee (fixed amount) plus a usage fee (variable).

3.2 APPLIED FACTORY OVERHEAD

An estimate of the next period's factory overhead costs is made which is then divided by a base, such as labor hours, machine hours, etc., and expressed as a predetermined rate. This predetermined rate helps management measure unit costs. If no predetermined rate is used, management would have to wait until the end of the period to know the amount of factory overhead costs and, therefore, the total cost per unit. Thus, it would be more difficult to quote selling prices to customers since costs would be less exact.

3.3 BASE TO BE USED

The base used to compute the predetermined factory overhead rate should be closely related to functions represented by the factory overhead cost being applied. Note that the base, like the total factory overhead costs, is an estimate of the future period's production quantity or cost. The five bases generally used to calculate the factory overhead rate are described below.

Units of Production. This method is considered the most efficient means of applying factory overhead.

The equation is:
$$\frac{\text{Estimated factory overhead}}{\text{Estimated units of production}} = \text{Factory overhead rate per unit}$$

EXAMPLE 1

Based on the units of production method, if 20,000 units are to be manufactured and the estimated factory overhead for the period is \$100,000, the factory overhead rate would be \$5 per unit (\$100,000 ÷ 20,000).

Direct Materials Cost. This method uses estimated total direct materials cost as a base, and the rate is expressed as a percentage. The equation is:

$$\frac{\text{Estimated factory overhead}}{\text{Estimated direct materials cost}} \times 100 = \text{Percentage of factory overhead per direct materials cost}$$

EXAMPLE 2

Suppose that estimated direct materials cost is \$50,000 and estimated factory overhead for the period is \$100,000. Using direct materials cost as the base, the factory overhead rate is computed as follows:

$$\frac{\$100,000}{\$50,000} \times 100 = 200\% \text{ of direct materials cost}$$

Direct Labor Cost. This base is widely used because of the high degree of correlation found in most cases between direct labor cost and factory overhead. The following equation is used:

$$\frac{\text{Estimated factory overhead}}{\text{Estimated direct labor cost}} \times 100 = \text{Percentage of direct labor cost}$$

EXAMPLE 3

Based on direct labor hours, an estimated direct labor cost of \$400,000 and estimated factory overhead per period of \$100,000 would result in an overhead rate of 25% of direct labor cost, since

$$\frac{\$100,000}{\$400,000} \times 100 = 25\%$$

Direct Labor Hours. When labor rates vary widely, direct labor hours may be more suitable than direct labor cost as a base. The equation in this case is:

$$\frac{\text{Estimated factory overhead}}{\text{Estimated direct labor hours}} = \text{Rate per direct labor hour}$$

EXAMPLE 4

If direct labor hours are estimated at 8,000 and estimated factory overhead per period is \$100,000, the factory overhead rate based on direct labor hours is calculated as follows:

$$\frac{\$100,000}{8,000} = \$12.50 \text{ per direct labor hour}$$

Machine Hours. When production is largely by machine, an appropriate basis would be the time required by a machine or group of machines to perform production operations. The base used is total estimated machine hours for the period. The equation is:

$$\frac{\text{Estimated factory overhead}}{\text{Estimated machine hours}} = \text{Rate per machine hour}$$

EXAMPLE 5

Assume that estimated machine hours equal 10,000 and estimated factory overhead per period is \$100,000. The factory overhead rate based on machine hours would be calculated as follows:

$$\frac{\$100,000}{10,000} = \$10 \text{ per machine hour}$$

In summary, the reader should note that in the above five methods the numerator is always the estimated factory overhead cost. The denominator changes with each method.

Note also that when costs or dollars are used as a base, a percentage rate is developed and therefore the fraction is multiplied by 100. When units or hours are used as a base, a dollar rate is developed.

3.4 ACTIVITY LEVEL TO BE USED

Normal or Long-run Capacity. This concept assumes a stable rate or capacity level of production over a period of time long enough to even out high and low levels of production. Therefore, the expected or estimated capacity used each period to compute factory overhead rates does not change.

Expected Actual or Short-run Capacity. The capacity expected for the next period may be used as a base to determine a factory overhead rate. Therefore, factory overhead rates may vary each period, depending on estimated changes in capacity levels, whereas the factory overhead rates based on normal capacity will remain constant even if expected actual capacity fluctuates.

Which Activity Level to Use. The use of normal capacity will result in a uniform cost per unit for different periods (assuming all other factors are constant), whereas the use of expected actual capacity may result in varying unit costs for different periods (if expected actual capacity changes). Therefore, the use of normal capacity is preferred because it eliminates the possible manipulation of unit costs by changing production levels. Expected actual capacity is generally used only when the normal production activity is difficult to determine.

3.5 JOURNALIZING FACTORY OVERHEAD

The journal entries to record factory overhead costs will depend on the cost accumulation system used and the amount of information desired by management. Actual factory overhead costs are basically recorded the same way under both periodic and perpetual systems (debit Factory Overhead Control and credit Cash, Vouchers Payable, Accumulated Depreciation, etc.) When a perpetual cost accumulation system is used, both actual and applied factory overhead costs are commonly recorded, whereas in a periodic cost accumulation system, only actual costs are recorded. The remaining examples in this chapter are presented on the assumption that a perpetual cost accumulation system is in use.

As was previously stated, actual factory overhead costs incurred during a period are debited to a Factory Overhead Control account. Ideally, the balance in the Factory Overhead Control account should equal the amount of factory overhead applied for the period. This rarely occurs in actual situations because of the difficulty in accurately estimating the extent of involvement of various factors (see [Section 3.6](#)). Only applied (not actual) factory overhead is charged to work-in-process inventory.

The Factory Overhead Applied account is closed out to the Factory Overhead Control account at

the end of the period. The Factory Overhead Control account debit balance and the Applied Factory Overhead account credit balance are compared to arrive at a net debit or credit balance. Some companies do not use a separate Factory Overhead Applied account; instead they credit factory overhead control for factory overhead applied.

EXAMPLE 6

Assume the following account balances:

Factory Overhead Control

1/5	7,000
1/8	9,000
1/12	10,000
1/28	6,000

Work-in-Process Inventory

1/15	15,000
1/31	25,000

Accounts Payable

1/5	7,000
1/8	9,000
1/12	10,000
1/28	6,000

Factory Overhead Applied

1/15	15,000
1/31	25,000

The entries to record rent of \$8,000 payable on January 31, 19X5 and to close out the Factory Overhead Control and Applied accounts are

<i>January 31</i>	<i>Factory Overhead Control—Rent</i>	<i>8,000</i>	
	<i> Accounts Payable</i>		<i>8,000</i>
<i>January 31</i>	<i>Factory Overhead Applied</i>	<i>40,000</i>	
	<i> Factory Overhead Control</i>		<i>40,000</i>

The entries are posted to the accounts as follows:

Factory Overhead Control

1/5	7,000	1/31	40,000
1/8	9,000		
1/12	10,000		
1/28	6,000		
1/31	8,000		
	<u>40,000</u>		<u>40,000</u>
	<u>40,000</u>		<u>40,000</u>

Work-in-Process Inventory

1/15	15,000
1/31	25,000

Accounts Payable

1/5	7,000
1/8	9,000
1/12	10,000
1/28	6,000
1/31	8,000

Factory Overhead Applied

1/31	40,000	1/15	15,000
		1/31	25,000
	<u>40,000</u>		<u>40,000</u>
	<u>40,000</u>		<u>40,000</u>

3.6 OVER-OR UNDERAPPLIED OVERHEAD

The balance in the factory overhead control account will usually not equal the balance in the Factory Overhead Applied account because of incorrect estimates of one or more of the following: (1) Estimated factory overhead cost for the period

- (2) Estimated production (did not equal normal capacity)
- (3) Labor or machine hour efficiency

EXAMPLE 7

Assume that the normal amount of time to complete a job is 100 direct labor hours and that factory

overhead is \$5 per direct labor hour (applied on the basis of direct labor hours). If a specific job took 105 direct labor hours (the 5 extra hours due to labor inefficiency), factory overhead would be overapplied by \$25 (5 extra hours \times \$5 per direct labor hour).

When factory overhead is over- or underapplied and a variance or difference results, either of the following two methods is acceptable to account for the difference in closing the account: (1) *To Cost of Goods Sold and Ending Inventories (if difference is significant)*

The over- or underapplied factory overhead may be debited or credited to Cost of Goods Sold and Ending Inventories. This would change cost per unit.

(2) *To Cost of Goods Sold (if difference is insignificant)*

The over- or underapplied factory overhead may be debited or credited to Cost of Goods Sold. This has no effect on unit cost and treats the entire variance as a period cost.

EXAMPLE 8

Assume the following data:

Underapplied factory overhead	\$12,000	
Units sold	80,000	(80%)
Units in ending work-in-process inventory	20,000	(20%)

The journal entries to close the Factory Overhead Applied account according to the two acceptable methods are shown below.

(1) *To Cost of Goods Sold and Work-in-Process Inventory:*

<i>Cost of Goods Sold</i>		
($\$12,000 \times 80\%$)	9,600	
<i>Work-in-Process Inventory</i>		
($\$12,000 \times 20\%$)	2,400	
<i>Factory Overhead Control</i>		12,000

(2) *To Cost of Goods Sold:*

<i>Cost of Goods Sold</i>	12,000	
<i>Factory Overhead Control</i>		12,000

3.7 ALLOCATION OF SERVICE DEPARTMENT COSTS TO PRODUCING DEPARTMENTS

There are two basic types of factory departments in a manufacturing company: producing departments and service departments. A producing department is one where the conversion or production takes place. A service department (e.g., personnel or maintenance) provides support to the producing departments. Since the producing departments are directly benefited by service departments, the expenses of a service department should be allocated to the appropriate producing departments (as part of factory overhead costs). One of the following methods may be used to allocate service department costs to producing departments: (1) Direct method

(2) Step method

(3) Algebraic method

Direct Method

This is the most common method of allocating service department costs to producing departments because of its mathematical simplicity and ease of application. It involves allocation of service department costs directly to producing departments and ignores any services provided by one service department to another.

EXAMPLE 9

Assume the following data for R. Mirador Rattan Industries:

Service Departments:

Dept. N, Maintenance	\$12,000
Dept. I, Cafeteria	5,500

Producing Departments:

Dept. C, Machinery	42,000
Dept. K, Assembly	78,700

The cost of the maintenance department is allocated to the producing departments based on the number of square feet; the cost of the cafeteria department is allocated based on the number of employees.

Department	Direct Labor Hours	Square Feet	Number of Employees
N, Maintenance	—	250	15
I, Cafeteria	—	900	12
C, Machinery	4,500	2,250	35
K, Assembly	<u>20,000</u>	<u>5,700</u>	<u>150</u>
Total	<u>24,500</u>	<u>9,100</u>	<u>212</u>

The service departments' costs allocation under the direct method and the calculation of factory overhead rate per direct labor hours is shown below:

Allocation of Costs

Direct Method

	Service Departments		Producing Departments	
	N, Maintenance	I, Cafeteria	C, Machinery	K, Assembly
Total Cost	\$12,000	\$5,500	\$42,000	\$78,700
Allocated to Producing Depts. C and K	<12,000> (c)		3,396 (a)	8,604 (b)
		<5,500> (f)	1,041 (d)	4,459 (e)
Balance after Allocation	<u>0</u>	<u>0</u>	<u>\$46,437</u>	<u>\$91,763</u>
Factory Overhead Rates per direct labor hour			<u>\$10.319 (g)</u>	<u>\$ 4.588 (h)</u>

Computations:

Allocation of Department N. Maintenance:

$$\frac{\text{Total cost}}{\text{Total square feet—Departments C and K}} = \text{Allocation rate}$$

$$\frac{\$12,000}{7,950 \text{ sq ft}} = \$1.50943/\text{sq ft}$$

			<u>Square Feet × Rate/Sq Ft</u>
(a) To Dept. C, Machinery	\$ 3,396	=	2,250 × \$1.50943
(b) To Dept. K, Assembly	<u>8,604</u>	=	5,700 × \$1.50943
(c) Total	<u><u>\$12,000</u></u>		

Allocation of Department I, Assembly:

$$\frac{\text{Total cost}}{\text{Total number of employees—Departments C and K}} = \text{Allocation rate}$$

$$\frac{\$5,500}{185 \text{ employees}} = \$29.72973/\text{employee}$$

			<u>Number of Employees × Rate/Employee</u>
(d) To Dept. C, Machinery	\$1,041	=	35 × \$29.72973
(e) To Dept. K, Assembly	<u>4,459</u>	=	150 × \$29.72973
(f) Total	<u><u>\$5,500</u></u>		

Factory overhead rates (based on direct labor hours) for producing departments:

			<u>Total Cost After</u>	\div	<u>Direct</u>
			<u>Allocation</u>		<u>Labor Hours</u>
(g) For Dept. C, Machinery	\$10.319	=	\$46,437	\div	4,500
(h) For Dept. K, Assembly	\$4.588	=	\$91,763	\div	20,000

Step Method

This method is more accurate than the direct method when services are provided to other service departments. The allocation of service department costs is performed by a series of steps: (1) The costs of the service department that provides services to the greatest number of other service departments are usually allocated first.

- (2) The costs of the service department that provides services to the next greatest number of service departments are then allocated. Any costs added to this department from step 1 are included. Note that under this method, the costs of subsequent service departments will not be allocated to the preceding service departments; thus any reciprocal services among service departments are ignored.
- (3) The sequence outlined above is continued, step by step, until all the service department costs have been allocated to producing departments.

EXAMPLE 10

Using the same data as in [Example 9](#), assume that the cost of the maintenance department is allocated first. The allocation of service department costs and the calculation of factory overhead rate per direct labor hour under the step method is as follows:

Allocation of Costs

Step Method

	Service Departments		Producing Departments	
	N, Maintenance	I, Cafeteria	C, Machinery	K, Assembly
Total Cost	\$12,000	\$5,500	\$42,000	\$78,700
Allocated to Service Dept. I and Producing Depts. C and K	<12,000>	<u>1,220 (a)</u>	<u>3,051 (b)</u>	<u>7,729 (c)</u>
Subtotal		\$6,720	\$45,051	\$86,429
Allocated to Producing Depts. C and K		<u><6,720></u>	<u>1,271 (d)</u>	<u>5,449 (e)</u>
Balance after Allocation	<u>0</u>	<u>0</u>	<u>\$46,322</u>	<u>\$91,878</u>
Factory Overhead Rates per direct labor hour			<u>\$10.294 (f)</u>	<u>\$ 4.594 (g)</u>

Computations:

Allocation of Department N. Maintenance:

$$\frac{\text{Total cost}}{\text{Square feet—Departments I, C, and K}} = \frac{\$12,000}{8,850} = \$1.35593/\text{sq ft}$$

			<u>Square Feet × Rate/Sq Ft</u>
(a) To Dept. I, Cafeteria	\$ 1,220	=	900 × \$1.35593
(b) To Dept. C, Machinery	3,051	=	2,250 × \$1.35593
(c) To Dept. K, Assembly	<u>7,729</u>	=	5,700 × \$1.35593
Total	<u><u>\$12,000</u></u>		

Allocation of Department I, Cafeteria:

$$\frac{\text{Total cost}}{\text{Total number of employees—Departments C and K}} = \frac{\$6,720}{185} = \$36.32432/\text{employee}$$

			<u>Number of Employees × Rate/Employee</u>
(d) To Dept. C, Machinery	\$1,271	=	35 × \$36.32432
(e) To Dept. K, Assembly	<u>5,449</u>	=	150 × \$36.32432
Total	<u><u>\$6,720</u></u>		

Factory overhead rates (based on direct labor hours) for producing departments:

			Total Cost After Allocation	÷	Direct Labor Hours
(f) For Dept. C, Machinery	\$10,294	=	\$46,322	÷	4,500
(g) For Dept. K, Assembly	\$4,594	=	\$91,878	÷	20,000

Algebraic Method

This is the most accurate of the three methods when reciprocal services are provided among the service departments. With the algebraic method, simultaneous equations are used to allocate service department costs to service departments and producing departments. The number of simultaneous equations is proportional to the number of service departments. The use of a computer facilitates the computations when many service departments exist.

EXAMPLE 11

In addition to the data from [Example 9](#), assume the following:

Services Provided by Department N Department I

Service Departments:

Dept. N, Maintenance	—	10%
Dept. I, Cafeteria	15%	—

Producing Departments:

Dept. C, Machinery	25%	20%
Dept. K, Assembly	<u>60%</u>	<u>70%</u>
Total	<u><u>100%</u></u>	<u><u>100%</u></u>

Using the algebraic method and the above percentages, the allocation of service department costs

to the producing departments is computed as follows:

The cost to be allocated by Department N, Maintenance: $N = \$12,000 + 0.10I$

The cost to be allocated by Department I, Cafeteria: $I = \$5,500 + 0.15N$

By substituting the above value for I (i.e., $\$5,500 + 0.15N$) for the unknown I in the first equation, we

$$N = \$12,000 + 0.10(\$5,500 + 0.15N)$$

$$N = \$12,000 + \$550 + 0.015N$$

$$N - 0.015N = \$12,000 + \$550$$

$$0.985N = \$12,550$$

can solve for N : $N = \$12,741$

3.8 THE FACTORY LEDGER

It is often practical for a manufacturing concern to include a factory ledger in its accounting system. Generally, this procedure is used when manufacturing operations are far from the main office, or when the nature of such operations requires a great number of accounts.

Most firms maintain cash and other factory assets on the general office records. Thus, the General Ledger includes such accounts as Sales, Cost of Goods Sold, Factory Equipment, Accumulated-Depreciation (depreciation expense for the period kept in the factory journal), and Liabilities. It also includes the control account, Factory Ledger.

Entries relating to the General Ledger and Factory Ledger are first recorded in the general journal and factory journal. The control accounts Factory Ledger and General Ledger are reciprocal in nature (i.e., a debit to one is an automatic credit to the other). They are used whenever a transaction affects both journals, should always equal each other, and cancel out for financial statement purposes. In essence, they permit each ledger to be self-balancing.

Because of the widespread use of computers in cost accounting and the ability to link computers through modems, use of the Factory Ledger has greatly decreased.

Solved Problems

3.1 Factory Overhead Rates. The Myriad Corporation estimates the following for the next period:

Factory overhead	\$250,000
Units produced	50,000
Materials cost of units produced	\$500,000

Production will require 50,000 labor hours at an estimated direct labor cost of \$100,000. The machine is estimated to run about 40,000 hours.

Determine the factory overhead rate to be used in applying factory overhead to production on each of the following bases: (a) units of production, (b) direct labor cost, (c) direct materials cost, (d) direct labor hours, and (e) machine hours.

SOLUTION

(a) Units of production

$$\frac{\text{Estimated factory overhead}}{\text{Estimated units of production}} = \frac{\$250,000}{50,000} = \$5 \text{ factory overhead per unit}$$

(b) Direct labor cost

$$\frac{\text{Estimated factory overhead}}{\text{Estimated direct labor cost}} \times 100 = \frac{\$250,000}{\$100,000} \times 100 = 250\% \text{ of direct labor cost}$$

(c) Materials cost

$$\frac{\text{Estimated factory overhead}}{\text{Estimated materials cost}} \times 100 = \frac{\$250,000}{\$500,000} \times 100 = 50\% \text{ of direct materials cost}$$

(d) Direct labor hours

$$\frac{\text{Estimated factory overhead}}{\text{Estimated direct labor hours}} = \frac{\$250,000}{50,000} = \$5 \text{ per direct labor hour}$$

(e) Machine hours

$$\frac{\text{Estimated factory overhead}}{\text{Estimated machine hours}} = \frac{\$250,000}{40,000} = \$6.25 \text{ per machine hour}$$

3.2 Factory Overhead: Journal Entries. Mint Airlines has factory overhead to be allocated. It maintains a work-in-process inventory account and a factory overhead control account. The

	July 3:	Indirect materials	\$ 500
	July 5:	Indirect labor	1,000
amounts are:	July 10:	Other expenses	3,000

During the month, 4,000 direct labor hours were worked. Factory overhead is applied at a rate of \$1.10 per direct labor hour at the end of the month.

Prepare the journal entries for factory overhead. Assume a perpetual cost accumulation system.

SOLUTION

<i>July 3</i>	<i>Factory Overhead Control,</i>	<i>500</i>	
	<i>Accounts Payable</i>		<i>500</i>
<i>July 5</i>	<i>Factory Overhead Control,</i>	<i>1,000</i>	
	<i>Payroll Payable</i>		<i>1,000</i>
<i>July 10</i>	<i>Factory Overhead Control,</i>	<i>3,000</i>	
	<i>Accounts Payable</i>		<i>3,000</i>
<i>July 31</i>	<i>Work-in-Process Inventory</i>		
	<i>(\$1.10 × 4,000)</i>	<i>4,400</i>	
	<i>Factory Overhead Applied</i>		<i>4,400</i>

3.3 Over-and Underapplied Overhead. The Overbrook Company manufactures widgets using a job order cost system with a predetermined factory overhead application rate based on direct labor hours. For the year ended June 30, 19X8, there were 200,000 direct labor hours used at the established rate of \$1.75 per direct labor hour. Actual factory overhead for the period amounted to \$360,000, composed of \$190,000 of indirect materials and \$170,000 of indirect labor. Overbrook Company uses a perpetual cost accumulation system.

Prepare journal entries to (a) record the total factory overhead costs to be applied to jobs, (b) close out the factory overhead applied to the Factory Overhead Control account, (c) accumulate total actual factory overhead, and (d) close out the underapplied factory overhead balance to Cost of Goods Sold.

SOLUTION

(a)	<i>Work-in-Process Inventory</i>	350,000	
	<i>Factory Overhead Applied (200,000 × \$1.75)</i>		350,000
(b)	<i>Factory Overhead Applied</i>	350,000	
	<i>Factory Overhead Control</i>		350,000
(c)	<i>Factory Overhead Control</i>	360,000	
	<i>Materials Inventory</i>		190,000
	<i>Payroll Payable</i>		170,000
(d)	<i>Cost of Goods Sold</i>	10,000	
	<i>Factory Overhead Control</i>		10,000

3.4 Factory Overhead: Service Departments' Cost Allocation. The Val Aur Company has two service departments and two producing departments.

Service Departments:	Total Cost
Dept. N, Factory Administration	\$12,900
Dept. J, Building and Grounds	10,500
Producing Departments:	
Dept. G, Machinery	41,600
Dept. P, Assembly	38,000

Additional Information:

Department	Estimated Total Labor Hours	Square Footage
N, Factory Administration	2,900	1,200
J, Building and Grounds	1,100	1,500
G, Machinery	2,000	1,900
P, Assembly	<u>1,600</u>	<u>3,200</u>
	<u><u>7,600</u></u>	<u><u>7,800</u></u>

The costs of factory administration are allocated based on estimated labor hours; building and grounds costs are allocated based on square footage. The producing departments compute these factory overhead rates based on machine hours, with 30,000 for machinery and 22,800 for assembly.

Allocate the costs of the service departments to the producing departments by using the following: (a) Direct Method, (b) Step Method (allocate the costs of factory administration first), and (c) Algebraic Method. Include the factory overhead rates for each producing department.

SOLUTION

(a)

Allocation of Costs

Direct Method

	Service Departments		Producing Departments	
	N, Factory Admin.	J, Bldg. and Grounds	G, Machinery	P, Assembly
Total Cost	\$12,900	\$10,500	\$41,600	\$38,000
Allocate to Producing Depts. G and P	<12,900>		7,167 (a)	5,733 (b)
		<10,500>	3,912 (c)	6,588 (d)
Balance after allocation	<u>0</u>	<u>0</u>	<u>\$52,679</u>	<u>\$50,321</u>
Factory overhead rates per machine hour			<u>\$1.75597 (e)</u>	<u>\$2.20706 (f)</u>

Computations:

Allocation of Department N. Factory Administration:

$$\frac{\text{Total cost}}{\text{Total estimated labor hours—Departments G and P}} = \frac{\$12,900}{3,600} = \$3.58333/\text{labor hour}$$

			<u>Labor Hours × Rate/Labor Hour</u>		
(a) To Dept. G. Machinery	\$ 7,167	=	2,000	×	\$3.58333
(b) To Dept. P. Assembly	<u>5,733</u>	=	1,600	×	\$3.58333
Total	<u>\$12,900</u>				

Allocation of Department J. Building and Grounds:

<u>Total cost</u>		<u>\$10,500</u>	=	<u>5,100</u>	=	\$2.05882/sq ft
<u>Total square feet—Departments G and P</u>						
				<u>Square Feet</u>	×	<u>Rate/Sq Ft</u>
(c)	To Dept. G, Machinery	\$ 3,912	=	1,900	×	\$2.05882
(d)	To Dept. P, Assembly	<u>6,588</u>	=	3,200	×	\$2.05882
	Total	<u>\$10,500</u>				

Factory overhead rates (based on machine hours) for producing departments:

				<u>Total Cost After</u>		<u>Machine Hours</u>
				<u>Allocation</u>	÷	
(e)	For Dept. G, Machinery	\$1.75597	=	\$52,679	÷	30,000
(f)	For Dept. P, Assembly	\$2.20706	=	\$50,321	÷	22,800

(b)

Allocation of Costs
Step Method

	Service Departments		Producing Departments	
	N, Factory Admin.	J, Bldg. and Grounds	G, Machinery	P, Assembly
Total cost	\$12,900	\$10,500	\$41,600	\$38,000
Allocated to Service Dept. J and Producing Depts. G and P	<12,900>	<u>3,019 (a)</u>	<u>5,489 (b)</u>	<u>4,392 (c)</u>
Subtotal		\$13,519	\$47,089	\$42,392
Allocated to Producing Depts. G and P		<u><13,519></u>	<u>5,036 (d)</u>	<u>8,483 (e)</u>
Balance after allocation	<u>0</u>	<u>0</u>	<u>\$52,125</u>	<u>\$50,875</u>
Factory overhead rates per ma- chine hour			<u>\$1.738 (f)</u>	<u>\$2.231 (g)</u>

Computations:

Allocation of Department N. Factory Administration:

$$\frac{\text{Total cost}}{\text{Total estimated labor hours—Departments J, G, and P}} = \frac{\$12,900}{4,700} = \$2.74468/\text{labor hour}$$

			<u>Labor Hours</u>	<u>×</u>	<u>Rate/Labor Hour</u>
(a)	To Dept. J, Building and Grounds	\$ 3,019	=	1,100	× \$2.74468
(b)	To Dept. G, Machinery	5,489	=	2,000	× \$2.74468
(c)	To Dept. P, Assembly	<u>4,392</u>	=	1,600	× \$2.74468
	Total	<u>\$12,900</u>			

Note: The cost allocated to Department P, Assembly includes the corrected rounding difference.

Allocation of Department J, Buildings and Grounds:

$$\frac{\text{Total cost}}{\text{Total square feet—Departments G and P}} = \frac{\$13,519}{5,100} = \$2.65078/\text{sq ft}$$

				<u>Square Feet</u>	<u>×</u>	<u>Rate/Sq Ft</u>
(d)	To Dept. G, Machinery	\$ 5,036	=	1,900	×	\$2.65078
(e)	To Dept. P, Assembly	<u>8,483</u>	=	3,200	×	\$2.65078
	Total	<u>\$13,519</u>				

Factory overhead rates (based on machine hours) for producing departments:

			<u>Total Cost After</u>	<u>÷</u>	<u>Machine</u>
			<u>Allocation</u>		<u>Hours</u>
(f)	For Dept. G, Machinery	\$1,738	=	\$52,125	÷ 30,000
(g)	For Dept. P, Assembly	\$2,231	=	\$50,875	÷ 22,800

(c)

Services Provided by

Department	Factory Administration (Labor Hours)	Building and Grounds (Square Feet)
N, Factory Administration	—	1,200
J, Building and Grounds	1,100	—
G, Machinery	2,000	1,900
P, Assembly	<u>1,600</u>	<u>3,200</u>
Total	<u><u>4,700</u></u>	<u>6,300</u>

Let N = Total cost of factory administration and J = Total cost of building and grounds.
The cost to be allocated to each department is then

$$N = \$12,900 + \frac{1,200}{6,300}J \quad \text{and} \quad J = \$10,500 + \frac{1,100}{4,700}N$$

By substitution we get

$$\begin{aligned} N &= \$12,900 + \frac{1,200}{6,300} \left(\$10,500 + \frac{1,100}{4,700}N \right) \\ N &= \$12,900 + \$2,000 + 0.04458N \\ 0.95542N &= \$14,900 \\ N &= \$15,595 \end{aligned}$$

By inserting the value for N in the equation for Department J, we get

$$J = \$10,500 + \frac{1,100}{4,700}(\$15,595) = \$10,500 + \$3,650 = \$14,150$$

**Allocation of Costs
Algebraic Method**

	Service Departments		Producing Departments	
	N, Factory Admin.	J, Bldg. and Grounds	G, Machinery	P, Assembly
Total cost	\$12,900	\$10,500	\$41,600	\$38,000
Allocated to Service Dept. J and Producing Depts. G and P	<15,595>	3,650 (a)	6,636 (b)	5,309 (c)
Allocated to Service Dept. N and Producing Depts. G and P	<u>2,695 (d)</u>	<u><14,150></u>	<u>4,268 (e)</u>	<u>7,187 (f)</u>
Balance after allocation	<u><u>0</u></u>	<u><u>0</u></u>	<u><u>\$52,504</u></u>	<u><u>\$50,496</u></u>
Factory overhead rates per machine hour			<u><u>\$1.750 (g)</u></u>	<u><u>\$2.215 (h)</u></u>

Computations:

Allocation of Department N. Factory Administration:

			<u>Proportionate Labor Hours</u>	\times	<u>Total Cost</u>
(a) To Dept. J, Building and Grounds	\$ 3,650	=	(1,100 \div 4,700)	\times	\$15,595
(b) To Dept. G, Machinery	6,636	=	(2,000 \div 4,700)	\times	\$15,595
(c) To Dept. P, Assembly	<u>5,309</u>	=	(1,600 \div 4,700)	\times	\$15,595
Total	<u><u>\$15,595</u></u>				

Allocation of Department J, Building and Grounds:

			<u>Proportionate Square Feet</u>	\times	<u>Total Cost</u>
(d) To Dept. N, Factory Administration	\$ 2,695	=	(1,200 \div 6,300)	\times	\$14,150
(e) To Dept. G, Machinery	4,268	=	(1,900 \div 6,300)	\times	\$14,150
(f) To Dept. P, Assembly	<u>7,187</u>	=	(3,200 \div 6,300)	\times	\$14,150
Total	<u><u>\$14,150</u></u>				

Note: The cost allocated to Department G, Machinery includes corrected rounding difference.

Factory overhead rates (based on machine hours) for producing departments

			<u>Total Cost After Allocation</u>	\div	<u>Machine Hours</u>
(g) For Dept. G, Machinery	\$1.750	=	\$52,504	\div	30,000
(h) For Dept. P, Assembly	\$2.215	=	\$50,496	\div	22,800

3.5 Factory Overhead Entries. The Wilson Company assembles and sells one product, the Speedy Blender. The costs per unit are: direct materials, \$15; direct labor, \$17. Production for year 19X8 is estimated to be 20,000 units; estimated factory overhead is: indirect labor, \$22,000;

indirect materials, \$16,000; depreciation, \$7,000; light and power, \$5,000; miscellaneous, \$10,000. Wilson Company uses a perpetual cost accumulation system.

Completed production for year 19X8 was 18,000 units, and actual factory overhead cost included indirect materials of \$26,000, indirect labor of \$18,000, depreciation of \$7,000, light and power of \$5,000, and no miscellaneous expenses. There were no beginning or ending work-in-process inventories.

Prepare (a) the journal entries for direct materials, direct labor and factory overhead, and (b) the entry to close over-or underapplied factory overhead to Cost of Goods Sold.

SOLUTION

(a) <i>Work-in-Process Inventory</i>	270,000	
<i>Materials Inventory (18,000 units × \$15)</i>		270,000
<i>Work-in-Process Inventory</i>	306,000	
<i>Payroll Payable (18,000 units × \$17)</i>		306,000
<i>Work-in-Process Inventory</i>	54,000	
<i>Factory Overhead Applied (18,000 × \$3*)</i>		54,000
<i>Factory Overhead Applied</i>	54,000	
<i>Factory Overhead Control</i>		54,000
<i>Factory Overhead Control</i>	56,000	
<i>Materials Inventory</i>		26,000
<i>Payroll Payable</i>		18,000
<i>Accumulated Depreciation</i>		7,000
<i>Accounts Payable</i>		5,000
(b) <i>Cost of Goods Sold (\$56,000 – \$54,000)</i>	2,000	
<i>Factory Overhead Control</i>		2,000

* Predetermined Factory Overhead Application Rate $(\$22,000 + \$16,000 + \$7,000 + \$5,000 + \$10,000) \div 20,000 = \3

Chapter 4

Job Order Cost System

4.1 JOB ORDER COST SYSTEM

The job order cost system is most suitable when the products differ in types of material and work performed. Thus, each product is made according to the customer's specifications and the price quoted is closely tied to estimated cost. Examples of types of companies which might use job order costing are printing companies and shipbuilding firms.

Under a job order cost system, the three basic elements of cost—direct materials, direct labor and factory overhead—are accumulated according to assigned job numbers. The unit cost for each job is obtained by dividing the total units for the job into the total cost. Selling and administrative costs are *not* considered part of the cost of the job and are shown separately on the cost sheet and income statement.

In order for a job order cost system to function properly, it is necessary to identify each job and segregate its related costs. Each individual order or batch is assigned a job number. Material requisitions, labor costs, and other charges carry the particular job number, and a cost sheet is used to summarize the applicable job costs. The profit or loss can be computed for each job and the unit cost can be computed for purposes of inventory costing.

EXAMPLE 1

Power Manufacturing Corporation uses a job order cost system during 19X1, these costs were incurred on the following open jobs:

Direct Materials

Direct Labor

Job #	Cost	Job #	Hours	Cost
H 702	\$16,872	L 1670	200	\$ 800
G 901	10,980	J 1901	3,000	9,600
B 168	5,670	H 702	500	1,575
		G 901	600	1,200
		B 168	90	180

Factory Overhead

Applied at \$2.00 per direct labor hour.

Work-in-Process Inventory—January 1, 19XX

Job #	Direct Materials	Direct Labor	Factory Overhead	Total
L 1670	\$1,500	\$6,000	\$8,000	\$15,500
J 1901	5,000	8,000	4,000	17,000

Sales

Job #	Selling Price
L 1670	\$ 18,000
J 1901	45,000
H 702	28,000
G 901	25,000
	<u>\$116,000</u>

Jobs Completed during the Year: #L 1670, #J 1901, #H 702, #G 901

Selling and Administrative Expenses: \$25,510

Computed below are (1) the cost of completed jobs, (2) the ending work-in-process inventory, and (3) the net income for the year.

(1) Cost of Completed Jobs

Job #	Opening W.I.P.	Direct Materials	Direct Labor	Factory Overhead	Total Cost
L 1670	\$15,500		\$ 800	\$ 400	\$16,700
J 1901	17,000		9,600	6,000	32,600
H 702		\$16,872	1,575	1,000	19,447
G 901		10,980	1,200	1,200	13,380
	<u>\$32,500</u>	<u>\$27,852</u>	<u>\$13,175</u>	<u>\$8,600</u>	<u>\$82,127</u>

(2) Work-in-Process Inventory-Ending

Job #	Opening W.I.P.	Direct Materials	Direct Labor	Factory Overhead	Total Cost
B 168	0	\$5,670	\$180	\$180	\$6,030

(3) Net Income

Sales	\$116,000
Cost of goods sold	<u>82,127</u>
Gross profit	\$ 33,873
Selling and administrative expenses	<u>25,510</u>
Net income	<u>\$ 8,363</u>

4.2 JOURNAL ENTRIES FOR JOB ORDER COST SYSTEM

The appropriate journal entries for a job order cost system are illustrated in [Example 2](#).

EXAMPLE 2

Sloane Manufacturing Company uses a job order cost system and compiled the following data during 19X1 for Job 1:

Materials and Supplies Purchased	\$242,000
Direct Material Used	190,000
Supplies Used (indirect materials)	20,000
Direct Labor	150,000
Indirect Labor	35,000
Utility Costs for Year Payable	65,000
Miscellaneous Overhead Payable	40,000
Depreciation, Equipment	22,000
Depreciation, Buildings	8,000
Applied Factory Overhead (120% of direct labor costs)	
Cost of Goods Manufactured	520,000
Sales	600,000
Cost of Goods Sold	326,000
Selling and Administrative Expenses	110,000

Shown below are (1) the appropriate journal entries and (2) the computation of net income.

(1) Journal Entries

Jan 3	Materials Inventory	242,000	
	Accounts Payable		242,000
Jan 10	Work-in-Process Inventory—Job 1	190,000	
	Factory Overhead Control	20,000	
	Materials Inventory		210,000
Jan 17	Work-in-Process Inventory—Job 1	150,000	
	Factory Overhead Control	35,000	
	Payroll Payable		185,000
Jan 19	Payroll Payable	185,000	
	Cash		185,000
Jan 24	Factory Overhead Control	135,000	
	Accounts Payable (\$65,000 + \$40,000)		105,000
	Accumulated Depreciation—Equipment		22,000
	Accumulated Depreciation—Building		8,000
Feb 1	Work-in-Process Inventory—Job 1	180,000	
	Factory Overhead Applied		180,000
	(\$150,000 direct labor × 120% = \$180,000)		
Feb 15	Finished Goods	520,000	
	Work-in-Process Inventory—Job 1		520,000
Mar 1	Cost of Goods Sold	326,000	
	Finished Goods		326,000
Mar 1	Accounts Receivable	600,000	
	Sales		600,000

(2) Net Income

Sales	\$600,000
Cost of goods sold	<u>326,000</u>
Gross profit	\$274,000
Selling and administrative expenses	<u>110,000</u>
Net income	<u><u>\$164,000</u></u>

4.3 JOB ORDER COST SHEET

This form is used to summarize the direct materials, direct labor, and factory overhead charged to a particular job. The form varies according to the needs of the particular company.

The materials cost and labor cost may be obtained from materials and labor summaries or may be recorded directly from materials requisitions and time tickets. Factory overhead is applied on the basis of a predetermined rate. The rate may be based on direct labor hours, direct labor cost, machine hours, *etc.* When there are two or more departments, it is usually desirable to have separate factory overhead rates for each department, or separate bases may be used. For example, factory overhead may be applied in Department A on the basis of machine hours and in Department B on the basis of direct labor hours.

In order to have additional information for the particular job readily available, many companies provide a summary on the cost sheet that includes the selling price as well as estimated selling and administrative expenses so that the estimated profit can be shown.

EXAMPLE 3

The Pompano Company received an order from the Bayville Company on July 13, 19X1 for 1,000 tea pots, model #6. The price is \$2.50 each, and delivery is promised in three months. Job No. 1201 was assigned to the order.

Direct Materials. Direct materials costs for the job, obtained from materials requisitions, are as follows:

Department A: August 5, 500 bases at \$0.80	\$400
August 10, 500 bases at \$0.90	450
Department B: September 8, 600 handles at \$0.30	\$180
September 20, 400 handles at \$0.50	200

Direct Labor. Direct labor costs obtained from time tickets are as follows:

Department A: August 15, Forming, 12 hours at \$10	\$120
August 20, Polishing, 10 hours at \$11	110
Department B: September 12, Assembly, 14 hours at \$8	112
September 25, Assembly, 13 hours at \$9	117

Factory Overhead. Factory overhead is applied when the job is completed or at the end of a period for jobs in process. The predetermined factory overhead rate is based on direct labor hours for each department as follows: Department A, \$5.00 per hour; Department B, \$6.00 per hour.

Selling and Administrative Expenses are based on 10% of selling price. The completed Job Cost Sheet for Job No. 1201 is shown in [Fig. 4-1](#).

POMPANO COMPANY

Job Order Cost Sheet

Customer: Bayville Company

Job No: 1201

Date Ordered: July 13, 19X1

Product: Copper Pot #6

Date Completed: October 13, 19X1

Quantity: 1,000

Direct Materials

Factory Overhead

Date	Description	Quantity	Cost	Amount
8/5	Bases, Dept. A	500	.80	\$ 400
8/10	Bases, Dept. A	500	.90	450
9/8	Handles, Dept. B	600	.30	180
9/20	Handles, Dept. B	400	.50	200
			Total	\$1,230

Month	Dept.	Hours	Rate	Amount
Aug.	A	22	\$5.00	\$110
Sept.	B	27	6.00	162
				Total \$272

Summary

Selling price	\$2,500
Factory Costs	
Direct Materials	\$1,230
Direct Labor	459
Factory Overhead	<u>272</u>
(Unit Cost: \$1.96)	<u>1,961</u>
Gross Profit (21.56%)	\$ 539
Selling & Admin. (10%)	<u>250</u>
Profit (11.56%)	<u>\$ 289</u>

Direct Labor

Date	Description	Hours	Rate	Amount
8/15	Forming, Dept. A	12	\$10	\$120
8/20	Polishing, Dept. A	10	11	110
9/12	Assembly, Dept. B	14	8	112
9/25	Assembly, Dept. B	13	9	117
			Total	\$459

4.4 SPOILED AND DEFECTIVE UNITS

Spoiled units are those that do not meet production standards and are either sold for their salvage value or discarded. *Defective units* do not meet production standards but are further processed to be sold as good units or as irregular units.

Normal spoilage is that which is expected to occur despite efficient production. Normal spoilage can be applied to all jobs by including an estimate for normal spoilage in the factory overhead application rate, or it can be allocated only to the job in which it occurs by transferring the salvage value out of work-in-process inventory into a spoiled units inventory.

Abnormal spoilage is that which is in excess of what is acceptable; therefore, the total cost of the abnormal spoiled units should be removed from work-in-process inventory, and any salvage value should be recorded in a Spoiled Units Inventory account.

The rework costs for *normal defective units* are treated in a manner similar to those for spoiled units: either applied to all jobs by including an estimate in the factory overhead application rate, or applied only to the affected job.

Costs incurred to rework *abnormal defective units* are charged to an account called Loss from Abnormal Defective Units and are thus treated as a period cost.

Solved Problems

4.1 Journal Entries. The J. Nelson Company maintains its cost records under the job order system. Selected cost data pertaining to Job A for the month of July, 19X1 are as follows:

Work-in-Process Inventory, July 1, 19X1 \$35,000

Transactions for July:

- | | |
|--|--------|
| (1) Raw materials purchased on credit | 45,000 |
| (2) Materials issued (indirect, \$5,000) | 35,000 |
| (3) Payroll (indirect, \$10,000) | 50,000 |
| (4) Factory overhead, actual | 60,000 |
| (5) Factory overhead is applied to production at 120% of direct labor. | |
| (6) Jobs with a cost of \$110,000 were completed in July. | |
| (7) Jobs costing \$140,000 were shipped out and billed at a markup of 25% on cost. | |

(a) Prepare the general journal entries for the above transactions. (b) Compute the work-in-process inventory amount at July 31, 19X1.

SOLUTION

(a) General Journal Entries

(1)	Materials Inventory	45,000	
	Accounts Payable		45,000
(2)	Work-in-Process Inventory—Job A	30,000	
	Factory Overhead Control	5,000	
	Materials Inventory		35,000
(3)	Work-in-Process Inventory—Job A	40,000	
	Factory Overhead Control	10,000	
	Payroll Payable		50,000
	Payroll Payable	50,000	
	Cash		50,000
(4)	Factory Overhead Control	60,000	
	Accounts Payable		60,000
(5)	Work-in-Process Inventory—Job A	48,000	
	Factory Overhead Applied (120% × \$40,000)		48,000
(6)	Finished Goods	110,000	
	Work-in-Process Inventory—Job A		110,000
(7)	Cost of Goods Sold	140,000	
	Finished Goods		140,000
(8)	Accounts Receivable	175,000	
	Sales (125% × \$140,000)		175,000

(b) Work-in-Process Inventory, July 31, 19X1

Work-in-Process Inventory

Balance 7/1	35,000	Completed in July	110,000
Direct Materials, July	30,000	Balance 7/31	43,000
Direct Labor, July	40,000		
Factory Overhead, July	<u>48,000</u>		
	<u>153,000</u>		<u>153,000</u>
Balance 7/31	43,000		

4.2 Job Order Cost Sheet. The Liebman Manufacturing Company produces expensive furniture by special order. One order was started and completed during August. There was no other production. Factory overhead is applied at a rate of \$4.00 per direct labor hour. Cost

Job 201

Direct materials	\$11,500
Direct labor	
Cost	\$10,500
Hours	3,500
Factory overhead	
Indirect materials	\$10,000
Other factory overhead	<u>3,000</u>
Total	<u>\$13,000</u>

information for the month was as follows:

Job 201 was ordered by the Binderman Company. They requested 1,000 rocking chairs. The selling price was \$40 per chair, and selling and administrative expenses relating to Job 201 were \$1,500.

Prepare a Job Order Cost Sheet. (Assume the order was placed on August 1 and the job was completed on August 31.) **SOLUTION**

LIEBMAN MANUFACTURING CO.

Job Order Cost Sheet

Customer: Binderman Co.

Job No: 201

Date Ordered: 8-1-XX

Product: Rocking Chairs

Date Completed: 8-31-XX

Quantity: 1,000

Direct Materials

Factory Overhead

Date	Description	Quantity	Cost	Amount	Month	Dept.	Hours	Rate	Amount	
8/31	Lumber			\$ 11,500	Aug.		3,500	\$4.00	\$14,000	
									Total \$14,000	
Summary										
									Selling price	\$40,000
									Factory Costs	
							Direct Materials	\$11,500		
							Direct Labor	10,500		
							Factory Overhead	<u>14,000</u>	<u>36,000</u>	
									Gross Profit	\$ 4,000
									Selling & Admin.	<u>1,500</u>
									Profit	<u><u>\$ 2,500</u></u>

Direct Labor

Date	Description	Hours	Rate	Amount
8/31		3,500	\$3.00	\$10,500
				Total \$10,500

Fig. 4-2.

4.3 Profit on Jobs. The Green Engineering Company produces specialized machine parts according to customer specifications. At January 1, 19X1, the following jobs were in process:

	Job #20	Job #28	Job #48
Direct Materials	\$4,000	\$ 8,000	\$3,300
Direct Labor	2,000	4,000	2,200
Factory Overhead	<u>1,000</u>	<u>2,000</u>	<u>1,100</u>
Totals	<u><u>\$7,000</u></u>	<u><u>\$14,000</u></u>	<u><u>\$6,600</u></u>

Additional costs to complete:

Direct materials: \$20,000, allocated as follows: Job #20, 40%; Job #28, 40%; and Job #48, 20%.

Direct labor: \$4,000 per job.

Factory overhead: 20% of direct labor.

Unit selling prices: Job #20, \$2.20; Job #28, \$2.50; Job #48, \$1.80.

Assuming the total unit cost for each job is \$2.00. (a) calculate the number of units completed on each job. (b) Compute the profit or loss on each job.

SOLUTION

Before unit costs can be computed, it is necessary to determine the total cost for each job, as follows:

Job #20	January 1	Additional	Total
Direct Materials	\$ 4,000	\$ 8,000	\$12,000
Direct Labor	2,000	4,000	6,000
Factory Overhead	<u>1,000</u>	<u>800</u>	<u>1,800</u>
Total	<u>\$ 7,000</u>	<u>\$12,800</u>	<u>\$19,800</u>

Job #28	January 1	Additional	Total
Direct Materials	\$ 8,000	\$ 8,000	\$16,000
Direct Labor	4,000	4,000	8,000

Factory Overhead	<u>2,000</u>	<u>800</u>	<u>2,800</u>
Total	<u><u>\$14,000</u></u>	<u><u>\$12,800</u></u>	<u><u>\$26,800</u></u>

Job #48	January 1	Additional	Total
Direct Materials	\$ 3,300	\$ 4,000	\$ 7,300
Direct Labor	2,200	4,000	6,200
Factory Overhead	<u>1,100</u>	<u>800</u>	<u>1,900</u>
Total	<u><u>\$ 6,600</u></u>	<u><u>\$ 8,800</u></u>	<u><u>\$15,400</u></u>

(a) Units Completed

	Total Cost		Unit Cost		Total Units
Job #20	\$19,800	÷	\$2.00	=	9,900
Job #28	26,800	÷	2.00	=	13,400
Job #48	<u>15,400</u>	÷	2.00	=	<u>7,700</u>
Totals	<u><u>\$62,000</u></u>				<u><u>31,000</u></u>

(b) Profit or Loss on Each Job

	Units	Unit Price		Selling Price	Total Cost	Profit (Loss)
		Selling	Cost			
Job #20	9,900	\$2.20	\$2.00	\$21,780	\$19,800	\$1,980
Job #28	13,400	2.50	2.00	33,500	26,800	6,700
Job #48	7,700	1.80	2.00	<u>13,860</u>	<u>15,400</u>	<u>(1,540)</u>
Totals				<u><u>\$69,140</u></u>	<u><u>\$62,000</u></u>	<u><u>\$7,140</u></u>

4.4 Factory Overhead Rates and Job Costs. The Tableau Manufacturing Company has been in business for one month. At the end of the month the company had the following account

Direct materials used	\$ 5,000
Direct labor	10,000
Indirect labor	3,000
Indirect materials	2,000
Labor fringe costs	1,000
Supervisor's salary	1,000
Depreciation of machinery	2,000
Miscellaneous factory overhead	1,000
Heat and light	500
Insurance on plant	1,500

balances on its books:

The company processed two jobs during the month as follows:

	Job 101	Job 102
Direct materials cost	\$3,000	\$2,000
Direct labor cost	6,000	4,000
Direct labor hours	4,000	3,000
Machine hours	2,000	1,000

The company does not use a predetermined rate for factory overhead. The rate is computed at the end of each month.

In terms of both direct labor hours and machine hours, compute (a) the factory overhead rates for the month, (b) the factory overhead cost of each job, and (c) the total cost for each job.

SOLUTION

(a) The factory overhead rates for the month are as follows:

$$\frac{\text{Factory overhead costs}}{\text{Total direct labor hours}} = \frac{\$12,000}{7,000} = \$1.71$$

$$\frac{\text{Factory overhead costs}}{\text{Total machine hours}} = \frac{\$12,000}{3,000} = \$4.00$$

(b) Factory overhead charged to jobs is as follows. For Job 101:

$$\text{Factory overhead rate} \times \text{direct labor hours} = \$1.71 \times 4,000 = \$6,840$$

$$\text{Factory overhead rate} \times \text{machine hours} = \$4.00 \times 2,000 = \$8,000$$

For Job 102:

$$\text{Factory overhead rate} \times \text{direct labor hours} = \$1.71 \times 3,000 = \$5,130$$

$$\text{Factory overhead rate} \times \text{machine hours} = \$4.00 \times 1,000 = \$4,000$$

(c) Total cost:

Job 101**Job 102**

Component Costs	Job 101		Job 102	
	Direct Labor Hours	Machine Hours	Direct Labor Hours	Machine Hours
Direct materials	\$ 3,000	\$ 3,000	\$ 2,000	\$ 2,000
Direct labor	6,000	6,000	4,000	4,000
Factory overhead	<u>6,840</u>	<u>8,000</u>	<u>5,130</u>	<u>4,000</u>
Total cost	<u>\$15,840</u>	<u>\$17,000</u>	<u>\$11,130</u>	<u>\$10,000</u>

4.5 FILL-INS

- (1) Units which must be sold for their salvage value are known as _____.
- (2) _____ units are further processed in order to be sold as good units.
- (3) _____ spoilage is expected to occur despite efficient production.
- (4) The total cost of abnormal spoiled units should be (a) _____ and any salvage value should be (b) _____.
- (5) Rework costs for normal defective units can be (a) _____ or (b) _____.

SOLUTION

- (1) spoiled units
- (2) defective
- (3) normal
- (4) (a) removed from work-in-process inventory
 (b) recorded in a Spoiled Units Inventory Account
- (5) (a) applied to all jobs
 (b) allocated to the job in which it occurs

Chapter 5

Process Cost System

5.1 INTRODUCTION

Under a process cost system, costs are accumulated according to each department, cost center, or process. For simplicity, this discussion of cost accumulation will refer to departments rather than to cost centers or processes. Note, however, that there may be two or more processes performed in one department (and therefore, more than one cost center in a department). In such cases, costs may vary significantly between cost centers, so it is desirable in practice to accumulate costs according to cost center or process rather than by department.

The average unit cost for a day, week, or year is obtained by dividing the department cost by the number of units (tons, gallons, etc.) produced during the particular period.

The process cost system is commonly used where products are manufactured under mass production methods or by continuous processing. Industries using process costs are paper, steel, chemicals, and textiles. Assembly-type processes such as washing machines and electrical appliances would also use process costs.

5.2 ACCUMULATION OF COSTS

In a process cost system procedures must be developed to:

- (1) Accumulate direct materials, direct labor, and factory overhead costs by department.
- (2) Determine the unit cost for each department.
- (3) Transfer costs from one department to the next.
- (4) Assign costs to work-in-process inventory.

The procedure to record the accumulation of costs is described below.

- (1) **Direct Materials Costs.** In a process cost system the number of requisitions or charges for direct materials is far lower than in a job order cost system, since charges are made to departments rather than to individual jobs. In some industries the type and quantity of direct materials may be specified by formulas or engineering specifications. When there is continuous use of the same direct materials, the usage each day or week is obtained from consumption reports rather than individual requisitions. The journal entry for recording direct materials would be

Work-in-Process Inventory—Department A 10,500

Materials Inventory

10,500

(2) **Direct Labor Costs.** The detail of accumulating direct labor costs by departments is also less than accumulating the same costs by individual jobs under the job order cost system. Direct labor costs to departments may be summarized in the payroll distribution entry as follows:

<i>Work-in-Process Inventory—Department A</i>	<i>6,000</i>	
<i>Work-in-Process Inventory—Department B</i>	<i>2,000</i>	
<i>Payroll Payable</i>		<i>8,000</i>

(3) **Factory Overhead Costs.** There is a greater difference between job order costing and process costing with respect to factory overhead than with direct materials or direct labor costs. Generally, production is more stable for process costing from month to month, since products are made for stock rather than to order. The entry to record factory overhead is

<i>Work-in-Process Inventory—Department A</i>	<i>9,000</i>	
<i>Work-in-Process Inventory—Department B</i>	<i>4,000</i>	
<i>Factory Overhead Applied</i>		<i>13,000</i>

When factory overhead costs accumulate fairly evenly throughout the year, or at a reasonably normal rate each month, many companies apply actual factory overhead to Work-in-Process Inventory. However, substantial fluctuation in production between months can distort the factory overhead charged to production. Thus, a predetermined factory overhead application rate based on a year's operation is frequently used to eliminate the difficulties of allocating factory overhead based on month-to-month differences in production.

5.3 DEPARTMENTAL TRANSFERS

Process costing is ordinarily used when products require a number of different production operations which are performed in two or more departments or cost centers. For example, the first operation may be performed in Department A, such as a machining or mixing process. After completion the units are transferred to Department B for an assembly or refining process. When this is completed, the units are transferred to finished goods inventory.

EXAMPLE 1

The Sunshine Company manufactures Product X, which requires processing in Departments A and B. During July 19X1, 5,000 units were placed in production and completed during the month. The costs were as follows: direct materials, \$10,000; direct labor, \$9,000; and factory overhead, \$6,000. The computations are:

Work-in-Process Inventory—Department A

	Total Cost	Unit Cost
Direct materials placed into production	\$10,000	\$2.00
Direct labor	9,000	1.80
Factory overhead	<u>6,000</u>	<u>1.20</u>
Total cost	<u><u>\$25,000</u></u>	<u><u>\$5.00</u></u>

The unit cost in each case is found by dividing the total cost by the number of units produced. When the process in Department A is completed, the 5,000 units and their total cost of \$25,000 are transferred to Department B.

5.4 FLOW OF UNITS

The flow of units (in terms of quantity) through a process cost system can be summarized by the following equation:

Units in process at beginning + Units started in process or transferred in (Units to account for)
= Units transferred out + Units completed and on hand
+ Units still in process (Units accounted for) When any four terms in the equation are known, the missing component can be computed from the equation. Note that all the components are not necessarily present in each situation (i.e., there may not always be units in process at the beginning of the period or units completed and still on hand at the end of the period).

EXAMPLE 2

Assume that the Bickerman Company had 1,500 units in work in process at the beginning of the month, put 5,000 units into process and had 1,000 units in work in process at the end of the month. All units completed were transferred out to Department B. The number of units transferred is

1,500	Units in process at beginning
+ <u>5,000</u>	Units started in process
6,500	Total units in process
- <u>1,000</u>	Units still in process
<u><u>5,500</u></u>	Units completed and transferred to Department B

computed as follows:

5.5 EQUIVALENT UNITS OF PRODUCTION

Rarely are all units placed in production during the month completed and sent to the next department by the end of the month. In most cases there will be beginning and ending inventories of work in process at different stages of completion each month.

To allocate costs when inventories of partially finished goods exist, all units (beginning work-in-process inventory and ending work-in-process inventory) must be expressed in terms of completed units. This is done by means of a common denominator, known as *equivalent units of production* or *equivalent production*. By using the equivalent production figure, the unit cost for the month would include the cost of completing any work in process at the beginning of the month and the cost to date of work in process at the end of the month.

Two separate equivalent production computations are usually needed, one for *direct materials* and another for direct labor and factory overhead, known as *conversion costs*.

There are two principal methods for costing work-in-process inventories: *average costing* and *first-in, first-out (FIFO) costing*. There are minor differences in cost report format or procedure; the major difference relates to the way in which the work-in-process inventories are treated.

Average Costing. Under this method, also known as weighted average costing, the opening work-in-process inventory costs are *merged* with the costs of the new period and a new average cost is obtained. Thus, there is only one average cost for goods completed.

Equivalent units under average costing may be computed as follows:

$$\text{Units Completed (Transferred out plus still on hand)} + [\text{Ending Work in Process} \times \text{Degree of Completion (\%)}]$$

This method is based on the assumption that *all* units in beginning work-in-process inventory were completed during the current period.

EXAMPLE 3

The following data relate to the activities of Department A during the month of May:

	Units
Beginning work-in-process inventory (100% complete as to direct materials, 70% complete as to conversion costs)	8,000
Goods started in process	86,000
Units transferred to Dept. B	80,000
Units completed and on hand	4,000
Ending work in process inventory (100% complete as to direct materials, 60% complete as to conversion costs)	10,000

Equivalent production in Department A for the month, using average costing, is computed as follows.

	Direct Materials	Conversion Costs
Units completed		
Transferred to Dept. B	80,000	80,000
Completed and on hand	4,000	4,000
Ending inventory units, amount completed:		
Direct materials (100%)	10,000	
Conversion costs (60%)		6,000
Equivalent production	<u>94,000</u>	<u>90,000</u>

This method adds the portion of beginning work-in-process inventory that was completed in the previous month to the current month's production. The result is that the portion of beginning work-in-process inventory completed during the previous period is counted twice, in this case once as last April's ending work-in-process inventory and again as May's beginning work-in-process inventory.

FIFO Costing. Under this method, the opening work-in-process inventory costs are *separated* from additional costs applied in the new period. Thus, there are two unit costs for the period: (1) opening work-in-process units completed and (2) units started and finished in the same period.

Under FIFO, the beginning work-in-process inventory is assumed to be completed and transferred first. The ending work-in-process inventory is then assumed to be from the goods put into production during the period. Thus, ending work-in-process inventory is calculated from current period unit costs according to degree of completion.

Equivalent units under FIFO Costing may be computed as follows:

- Units Completed (Transferred out plus still on hand)
 - Beginning Work-in-Process Inventory (regardless of stage of completion)
 - + Amount needed to complete Beginning Work-in-Process Inventory
 - + Amount completed in Ending Work-in-Process Inventory **EXAMPLE 4**

Using the same data as in [Example 3](#), we compute the equivalent production for Department A under the FIFO method as follows.

	Units	
	Direct Materials	Conversion Costs
Units completed and transferred		
Transferred to Dept. B	80,000	80,000
Completed and on hand	4,000	4,000
Less: Beginning work-in-process inventory	<u>< 8,000 ></u>	<u>< 8,000 ></u>
Started and completed during this period	76,000	76,000
Completion of beginning work-in-process inventory		
Direct materials (0%)	0	
Conversion costs (30%)		<u>2,400</u>
	<u>76,000</u>	<u>78,400</u>
Ending inventory units, amount completed		
Direct materials (100%)	10,000	
Conversion costs (60%)		<u>6,000</u>
Equivalent production	<u><u>86,000</u></u>	<u><u>84,400</u></u>

Equivalent production under FIFO may also be computed by subtracting the portion of beginning work in process inventory that was completed during the previous month from equivalent production under average costing.

	Units	
	Direct	Conversion
	Materials	Costs
Equivalent production, average costing (from Example 3)	94,000	90,000
Less: Beginning work-in-process inventory (portion completed last month)		
Direct materials (100%)	(8,000)	
Conversion costs (70%)		(5,600)
Equivalent production, FIFO costing	<u>86,000</u>	<u>84,400</u>

The FIFO method is superior to the average costing method in that it corrects the double count resulting from the carry-over of the previous month's work-in-process inventory. Even with this inherent inaccuracy in the average method, it is still commonly used in business because the double count usually represents an insignificant portion of the total units produced.

5.6 COST OF PRODUCTION REPORT

The Cost of Production Report shows all costs chargeable to a department or cost center for the period. Since its principal objective is the control of costs, detailed data relating to total and unit costs must be provided. Typically, the cost breakdown is made by cost elements for each department (or cost center). This report is also a good source for summary journal entries prepared at the end of the month.

The cost of production report generally contains four sections:

- (1) **Quantities.** This section accounts for the physical flow of *units* into and out of a department.
- (2) **Equivalent Production.** This section shows the sum of: (1) units still in process, restated in terms of completed units, and (2) total units actually completed. [Section 5.5](#) illustrated the computation of equivalent units of production under both average costing and FIFO costing.
- (3) **Costs to Account For.** This section accounts for the *incurrence* of costs that were: (1) *in process* at the beginning of the period, (2) *transferred in* from previous departments, and (3) *added* by the department.

(4) *Costs Accounted For*. This section accounts for the *disposition* of costs charged to the department. Were the costs: (1) *transferred out* to another department or to finished goods? (2) *completed and on hand*? (3) *still in process* at the end of the period? It should be noted that the total of the *Costs to Account For* must equal the total of the *Costs Accounted For*.

The Cost of Production Report may be greatly detailed (i.e., item by item) or may show only totals, depending on the needs of the business and the desire of management. In our presentation we will show the breakdown according to cost elements in each of the cost categories.

EXAMPLE 5

The Vogel Manufacturing Corporation uses the first-in, first-out method of process costing. The following data relate to the operations of Department A during the month of July, 19X1: **Production (in units)**

Beginning work-in-process inventory (100% complete as to direct materials; 60% complete as to conversion costs)	1,500
Started in process	5,000
Transferred to Dept. B	5,500
Ending work-in-process inventory (100% complete as to direct materials; 60% complete as to conversion costs)	1,000

Costs in Beginning Inventory		Costs Added during the Month	
Direct materials	\$1,680	Direct materials	\$10,000
Direct labor	1,400	Direct labor	8,500
Factory overhead	<u>1,120</u>	Factory overhead	<u>6,800</u>
Total	<u><u>\$4,200</u></u>	Total	<u><u>\$25,300</u></u>

The July Cost of Production Report for Department A is shown below.

The Vogel Manufacturing Corporation

Cost of Production Report, Department A
FIFO Costing Method
for the month of July, 19X1

(Section 1)**Quantities**

Units to account for:

Beginning units in process	1,500	
Units started in process	<u>5,000</u>	<u>6,500</u>

Units accounted for:

Units transferred to next department	5,500	
Ending units in process	<u>1,000</u>	<u>6,500</u>

(Section 2)**Equivalent Production**

	<u>Direct Materials</u>	<u>Conversion Costs</u>	<u>(Computations)</u>
Units completed and transferred	5,500	5,500	
- Beginning units in process	<u>1,500</u>	<u>1,500</u>	
= Units started and completed	4,000	4,000	
+ Amount needed to complete beginning work-in-process inventory	0	600	(1,500 × 40%)
+ Ending units in process	<u>1,000</u>	<u>600</u>	(1,000 × 60%)
Total equivalent units	<u>5,000</u>	<u>5,200</u>	

(Section 3)**Costs to Account For**

From current production:

Units started and completed

(4,000 × \$4.943)

19,772

Total transferred

\$25,738

Work-in-process inventory—
ending:

Direct materials (1,000 × \$2.000) \$2,000

Direct labor (1,000 × \$1.635 ×
60%) 981

Factory overhead (1,000 ×
\$1.308 × 60%) 785 3,766

Total \$29,504

Less: Rounding difference (4)

Total costs accounted for \$29,500

EXAMPLE 6

If the Vogel Manufacturing Corporation had used the average costing method instead of FIFO, its Cost of Production Report for the month of July would have appeared as shown below. The data are the same as in [Example 5](#).

*The Vogel Manufacturing Corporation
Cost of Production Report, Department A
Average Costing Method
for the month of July, 19X1*

(Section 1)**Quantities**

Units to account for:

Beginning units in process	1,500	
Units started in process	<u>5,000</u>	6,500

Units accounted for:

Units transferred to next department	5,500	
Ending units in process	<u>1,000</u>	<u>6,500</u>

(Section 2)**Equivalent Production**

	<u>Direct Materials</u>	<u>Conversion Costs</u>	<u>(Computations)</u>
Units completed and transferred	5,500	5,500	
Ending units in process	<u>1,000</u>	<u>600</u>	(1,000 × 60%)
Total equivalent units	<u>6,500</u>	<u>6,100</u>	

(Section 3)**Costs to Account For**

<u>Total Cost</u>	÷	<u>Equivalent Production</u>	=	<u>Equivalent Unit Cost</u>
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Costs added by department:

Direct materials

Work-in-process inventory—

beginning \$ 1,680

Added during the period 10,000

Total \$11,680 6,500 \$1,797

Direct labor

Work-in-process inventory—

beginning \$1,400

Added during the period 8,500

Total \$ 9,900 6,100 1,623

Factory overhead

Work-in-process inventory—

beginning \$ 1,120

Added during the period 6,800

Total \$ 7,920 6,100 1,299

Total costs to account for \$29,500 \$4,719

(Section 4)**Costs Accounted For**

Transferred to next department:

(5,500 × \$4.719) \$25,954

Work-in-process inventory—
ending:

Direct materials (1,000 × \$1.797) \$1,797

Direct labor (1,000 × \$1.623 ×
60%) 974

Factory overhead (1,000 ×
\$1.299 × 60%) 3,550

Less: Rounding difference (4)

Total costs accounted for \$29,500

5.7 JOURNAL ENTRIES

Two sets of journal entries are needed to record the information developed in the Cost of Production Report.

(1) *Entry for Costs to Account For.* The following entry is needed to record the costs put into process in the current period:

<i>Work-in-Process Inventory—Department A</i>	<i>XX</i>	
<i>Materials Inventory</i>		<i>XX</i>
<i>Payroll Payable</i>		<i>XX</i>
<i>Factory Overhead Applied</i>		<i>XX</i>

(2) *Entry for Costs Accounted For.* The following entry is needed to record the costs transferred out:

<i>Work-in-Process Inventory—Department B</i>	<i>XX</i>
<i>Work-in-Process Inventory—Department A</i>	<i>XX</i>

EXAMPLE 7

Continuing with the Vogel Manufacturing Corporation data in [Examples 5](#) and [6](#), the journal entry to record costs put into the process in Department A is as follows, whether average costing or FIFO is used:

<i>Work-in-Process Inventory—Department A</i>	<i>25,300</i>	
<i>Materials Inventory</i>		<i>10,000</i>
<i>Payroll Payable</i>		<i>8,500</i>
<i>Factory Overhead Applied</i>		<i>6,800</i>

Under FIFO, the entry to record transfer of costs to Department B is

<i>Work-in-Process Inventory—Department B</i>	<i>25,738</i>	
<i>Work-in-Process Inventory—Department A</i>		<i>25,738</i>

5.8 SECOND DEPARTMENT AND INTRODUCTION OF ADDITIONAL MATERIALS

While in many cases all direct materials are introduced at the beginning of the process, it is sometimes necessary to include additional direct materials in departments subsequent to the first. In such instances, there are two possible effects on units and related costs: (1) The number of final units *remains the same while the unit cost increases*. In this case, the treatment of the additional direct materials cost is identical to that for the inclusion of all direct materials in the first department (i.e., it is included in “Cost Added by Department”; that total is divided by the appropriate equivalent units figure to derive the periodic unit cost).

(2) The number of final units *increases* while unit cost *decreases*. When this occurs, an adjustment of the preceding department’s unit cost becomes necessary, because the same total cost will be allocated over a greater number of units.

EXAMPLE 8

Assume the following information for Department 2:

Costs transferred in from Dept. 1	\$50,000
Units transferred in from Dept. 1	20,000
Additional units put into process in Dept. 2	5,000

The preceding department's unit cost to be used in Department 2 is computed as follows:

$$\$50,000 \text{ (cost transferred in)} \div 25,000 \text{ units} = \$2 \text{ per unit}$$

5.9 COST OF PRODUCTION REPORT—SECOND DEPARTMENT

The Cost of Production Report for a subsequent department is generally the same as that for the first department except that it contains a section for units and costs transferred in.

EXAMPLE 9

The Cost of Production Report prepared in [Example 6](#) will be used as the basis for this example. There was no beginning work-in-process inventory in Department B, and no additional direct materials were added in this department.

Of the 5,500 units transferred in from Department A, 4,000 were transferred to finished goods. The ending work-in-process inventory was 80% complete as to conversion costs.

Direct labor of \$6,000 and factory overhead of \$4,500 were added by Department B.

The August Cost of Production Report for Department B follows:

The Vogel Manufacturing Corporation
Cost of Production Report, Department B
Average Costing Method
for the month of August, 19X1

Quantities

Units to account for:

Units received from
Department A

5,500

Units accounted for:

Units transferred to finished
goods

4,000

Ending units in process

1,500

5,500

Equivalent Production

Conversion
Costs

Units transferred to finished goods

4,000

Ending units in process

1,200

(1,500 × 80%)

Total equivalent units

5,200

Costs to Account For

	<u>Total Cost</u>	÷	<u>Equivalent Production</u>	=	<u>Equivalent Unit Cost</u>
Costs from preceding department:					
Transferred in during the period	\$25,954		5,500		\$4.719
Costs added by department:					
Direct labor					
Added during the period	6,000		5,200		1.154
Factory overhead					
Added during the period	<u>4,500</u>		5,200		<u>.865</u>
Total costs to account for	<u><u>\$36,454</u></u>				<u><u>\$6.738</u></u>

Costs Accounted For

Transferred to finished goods inventory (4,000 × \$6.738)	\$26,952
Work-in-process inventory— ending:	
Costs from preceding depart- ment (1,500 × \$4.719)	7,079
Direct labor (1,500 × \$1.154 × 80%)	1,385
Factory overhead (1,500 × \$.865 × 80%)	<u>1,038</u>
Total costs accounted for	<u><u>\$36,454</u></u>

5.10 SPOILED UNITS (GOODS)

Units that do not meet production standards and are either sold for their salvage value or discarded are called spoiled units. When spoiled units are discovered, they are immediately taken out of production, and no further work is performed on them. The amount of spoilage for a period can be considered either normal or abnormal.

Normal. Spoilage that results from an efficient production process is called normal spoilage. It is the unavoidable cost of producing good units.

Abnormal. Spoilage that exceeds what is considered normal for a particular production process is called abnormal spoilage. It is controllable and results from inefficient operations.

5.11 ACCOUNTING FOR SPOILED UNITS

(1) Spoilage in the First Department

Method 1—Theory of Neglect. Spoiled units are considered as not put into production at all. Equivalent unit cost increases as costs are allocated over fewer units. This method is used because of its simplicity, but it is not the preferred method because it does not distinguish between normal and abnormal spoilage.

Method 2—Spoilage as a Separate Element of Cost. This method establishes a separate cost for spoiled units. The spoiled units are included in the computation of equivalent production up to the point at which they were removed from production (usually the point of inspection). Once the cost is recognized, it can be further allocated between normal and abnormal spoilage. Abnormal spoilage cost is considered to be a period cost, while normal spoilage is considered to be a product cost.

(2) Spoilage in Subsequent Departments

Method 1—Theory of Neglect. Spoiled units after the first department are also considered as never having been put in production. The transferred-in cost is higher because spoiled units were not removed from production in the first department. The number of transferred-in units is reduced by the number of spoiled units, thereby allocating transferred-in costs to fewer units. The unit cost for units started and completed is also greater as the cost of spoiled units is absorbed.

Method 2—Spoilage as a Separate Element of Cost. Total spoilage cost is equal to the sum of transferred-in cost of spoiled units plus spoilage costs in the current department. Computed as

$$\begin{aligned}
 \text{Total spoilage cost} &= \left(\begin{array}{l} \text{Number of} \\ \text{spoiled units} \end{array} \times \begin{array}{l} \text{Transferred-} \\ \text{in cost} \end{array} \right) \\
 &+ \left(\begin{array}{l} \text{Equivalent} \\ \text{production of} \\ \text{spoiled units} \end{array} \times \begin{array}{l} \text{Equivalent} \\ \text{unit cost} \end{array} \right)
 \end{aligned}$$

follows:

EXAMPLE 10

To illustrate the computation of spoilage costs, assume the following:

Units transferred in from Department 1	5,000
Normal spoilage in Department 2 (units)	40
Cost per unit of units transferred in	\$8
Unit costs for Department 2:	
Direct materials	\$2.00
Direct labor	.60
Factory overhead applied	.90

There was no beginning work-in-process inventory, and spoiled units were removed when conversion costs were 50% complete. All the direct materials were added at the beginning of the process.

Method 1—Theory of Neglect

<u>Units</u>	<u>Total Cost</u>	÷	<u>Equivalent Production</u>	=	<u>Equivalent Unit Cost</u>
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Costs from preceding dept.:

Transferred in during period (5,000 × \$8.00)	5,000	\$40,000		4,960	\$8.06
Less: Total spoiled units	<u>-40</u>				
Adjusted units and unit cost	<u><u>4,960</u></u>				

Note that the equivalent unit cost increased from \$8.00 to \$8.06 because the costs are spread over the remaining good units.

Method 2—Spoilage as a Separate Element of Cost

Transferred-in equivalent unit cost from Department 1 ($40 \times \$8.00$)		\$320
Costs added by department 2:		
Direct materials ($40 \times \$2 \times 100\%$)	\$80.00	
Direct labor ($40 \times \$0.60 \times 50\%$)	12.00	
Factory overhead ($40 \times \$0.90 \times 50\%$)	<u>18.00</u>	<u>110</u>
Total spoilage cost		<u><u>\$430</u></u>

Note that with this method, actual spoilage cost is computed. Management can identify the units and further allocate the cost between normal and abnormal spoilage.

Solved Problems

5.1 Flow of Units; Quantity Schedules. The Katz Supply Company manufactures door knobs. The products pass through two departments. Department A had 5,500 door knobs in process on July 1, and 2,500 in process on July 31. During the month, 6,000 door knobs were transferred to Department B for further processing. There were no completed units on hand at the end of the month.

(a) Compute the number of door knobs started in process during July and (b) prepare a quantity schedule for Department A.

SOLUTION

(a) Let x = the number of units started in process.

$$\begin{aligned}
 5,500 + x &= 6,000 + 0 + 2,500 \\
 x &= 8,500 - 5,500 \\
 x &= 3,000
 \end{aligned}$$

(b)

Quantity Schedule

Units to account for

Units in process at beginning
of period

5,500

Units started in process

3,000

8,500

Units accounted for

Units transferred to next
department

6,000

Units still in process at end
of period

2,500

8,500

5.2 Flow of Units; Quantity Schedules. The Meyer Manufacturing Company manufactures woolen mittens that require processing in two departments, A and B. During the month of October, Department A completed 10,500 mittens, of which 8,000 were transferred to Department B. There were 500 mittens in process in Department A and 300 in Department B on October 1. During the month, 15,000 additional mittens were started in production in Department A; no additional units were added by Department B. All 7,000 mittens completed during the month were transferred from Department B to the finished goods storeroom. The remaining units for Departments A and B were still in process on October 31.

For each department (a) compute the number of units still in process on October 31, and (b) prepare a quantity schedule.

SOLUTION

(a) Let x = the number of units still in process.

Department A**Department B**

$$500 + 15,000 + 0 = 8,000 + 2,500 + x \quad 300 + 0 + 8,000 = 7,000 + 0 + x$$

$$15,500 = 10,500 + x \quad 8,300 = 7,000 + x$$

$$5,000 = x \quad 1,300 = x$$

(b)

Quantity Schedules

	Department A	Department B
<i>Units to account for</i>		
Units in process at beginning	500	300
Units started in process	15,000	
Units from preceding department		8,000
	<u>15,500</u>	<u>8,300</u>
<i>Units accounted for</i>		
Units transferred to next department	8,000	7,000
Units completed and on hand	2,500	
Units still in process	5,000	1,300
	<u>15,500</u>	<u>8,300</u>

5.3 Equivalent Production—Average Costing. The following information is available for the Blutter Manufacturing Company:

	Units	
Work in process, January 1		
(75% complete as to direct materials and conversion costs)	4,000	
Units started in process	<u>46,000</u>	<u>50,000</u>
Units transferred out	36,000	
Units completed and on hand	8,000	
Units still in process, January 31		
(100% direct materials; 40% conversion costs)	<u>6,000</u>	<u>50,000</u>

Compute the equivalent units for the Blutter Manufacturing Company using the average costing method.

SOLUTION

	Direct Materials	Conversion Costs	(Computations)
Units completed			
Transferred to next department	36,000	36,000	
Still on hand	8,000	8,000	
Ending units in process			
Direct materials	6,000		(6,000 × 100%)
Conversion costs		<u>2,400</u>	(6,000 × 40%)
Total equivalent units	<u>50,000</u>	<u>46,400</u>	

5.4 Equivalent Production—FIFO. Using the data in Problem 5.3, compute the equivalent units under the FIFO costing method.

SOLUTION

	Direct Materials	Conversion Costs	(Computations)
Units completed			
Transferred out	36,000	36,000	
Still on hand	8,000	8,000	
Less: Beginning work-in-process inventory	<u>(4,000)</u>	<u>(4,000)</u>	
	40,000	40,000	
Amount needed to complete beginning work in process	<u>1,000</u>	<u>1,000</u>	(4,000 × 25%)
	41,000	41,000	
Ending units in process:			
Direct materials	6,000		(6,000 × 100%)
Conversion costs		2,400	(6,000 × 40%)
Total equivalent units	<u><u>47,000</u></u>	<u><u>43,400</u></u>	

5.5 Cost of Production Report: Average Costing. The Nan Corporation manufactures typewriters and uses a process cost system to account for the costs. Production is done in two departments and the average costing method is used. The following information is available for you to prepare a cost of production report (a) for Department 1 and (b) for Department 2.

Units	Dept. 1	Dept. 2
Beginning units in process		
Department 1:		
100% direct materials; 20% complete as to conversion costs	6,000	
Department 2:		
100% direct materials; 70% complete as to conversion costs		8,000
Started in process during the period	45,000	—
Received in from Department 1	—	42,000
Transferred to finished goods	—	45,000
Ending units in process		
Department 1:		
100% direct materials; 75% complete as to conversion costs	9,000	
Department 2:		
100% direct materials; 40% complete as to conversion costs		5,000

Costs	Dept. 1	Dept. 2
Beginning work-in-process inventory		
From preceding department	\$ 0	\$ 57,720
Direct materials	8,000	0
Direct labor	5,000	18,000
Factory overhead	3,000	8,000
	<u>\$ 16,000</u>	<u>\$ 83,720</u>
Added during the period		
Direct materials	\$200,000	\$ 0
Direct labor	100,000	150,000
Factory overhead	90,000	120,000
	<u>\$390,000</u>	<u>\$270,000</u>

SOLUTION

(a)

Nan Corporation
Cost of Production Report, Department I
Average Costing Method

Quantities

Units to account for:

Beginning units in process	6,000	
Units started in process	<u>45,000</u>	<u>51,000</u>

Units accounted for:

Units transferred to Department 2	42,000	
Ending units in process	<u>9,000</u>	<u>51,000</u>

Equivalent Production

	Direct <u>Materials</u>	Conversion <u>Costs</u>	<u>(Computations)</u>
Units completed and transferred	42,000	42,000	
Ending units in process	<u>9,000</u>	<u>6,750</u>	(9,000 × 75%)
Total equivalent units	<u>51,000</u>	<u>48,750</u>	

Costs to Account For

	<u>Total Cost</u>	÷	<u>Equivalent Production</u>	=	<u>Equivalent Unit Cost</u>
Costs added by department:					
Direct materials					
Work-in-process inventory— beginning	\$ 8,000				
Added during the period	<u>200,000</u>				
Total	<u>\$208,000</u>		51,000		\$4.078
Direct labor:					
Work-in-process inventory— beginning	5,000				
Added during the period	<u>100,000</u>				
Total	<u>\$105,000</u>		48,750		2.154
Factory overhead:					
Work-in-process inventory— beginning	3,000				
Added during the period	<u>90,000</u>				
Total	<u>\$ 93,000</u>		48,750		<u>1.908</u>
Total costs to account for	<u><u>\$406,000</u></u>				<u><u>\$8.140</u></u>

Costs Accounted For

Transferred to Department 2:	
(42,000 × \$8.140)	\$341,880
Work-in-process inventory—ending:	
Direct materials (9,000 × \$4.078)	36,702
Direct labor (9,000 × \$2.154 × 75%)	14,540
Factory overhead (9,000 × \$1.908 × 75%)	<u>12,879</u>
Less: rounding difference	<u>(1)</u>
Total costs accounted for	<u><u>\$406,000</u></u>

(b)

Nan Corporation
Cost of Production Report, Department 2
Average Costing Method

Quantities

Units to account for:

Beginning units in process	8,000	
Received from preceding department	<u>42,000</u>	<u>50,000</u>

Units accounted for:

Units transferred to finished goods inventory	45,000	
Ending units in process	<u>5,000</u>	<u>50,000</u>

Equivalent Production

	<u>Direct Materials</u>	<u>Conversion Costs</u>	<u>(Computations)</u>
Transferred to finished goods inventory	45,000	45,000	
Ending units in process	<u>5,000</u>	<u>2,000</u>	(5,000 × 40%)
Total equivalent units	<u>50,000</u>	<u>47,000</u>	

Costs to Account For

	<u>Units</u>	<u>Total Cost</u>	÷	<u>Equivalent Production</u>	=	<u>Equivalent Unit Cost</u>
Costs from preceding department:						
Work-in-process inventory—beginning	8,000	\$ 57,720				

Transferred in during the period:

42,000 341,880

50,000 \$399,600

50,000

\$ 7.99200

Costs added by department:

Direct labor

Work-in-process inventory—beginning

\$ 18,000

Added during the period

150,000

Total

\$168,000

47,000

3.57446

Factory overhead:

Work-in-process inventory—beginning

\$ 8,000

Added during the period

120,000

Total

\$128,000

47,000

2.72340

Total costs to account for

\$695,600

\$14.28986

Costs Accounted For

Transferred to finished goods

inventory ($45,000 \times \$14.28986$) \$643,044

Work-in-process inventory—ending:

Costs from preceding department

($5,000 \times \$7.992$) 39,960

Direct labor ($5,000 \times$

$\$3.57446 \times 40\%$) 7,149

Factory overhead ($5,000 \times$

$\$2.72340 \times 40\%$) 5,447

Total costs accounted for

\$695,600

5.6 Cost of Production Report: FIFO. Recompute Problem 5.5 under FIFO costing.

SOLUTION

(a)

Nan Corporation
Cost of Production Report, Department I
FIFO Costing Method

Quantities

Costs to account for:

Beginning units in process	6,000	
Units started in process	<u>45,000</u>	<u>51,000</u>

Costs accounted for:

Units transferred to Department 2	42,000	
Ending units in process	<u>9,000</u>	<u>51,000</u>

Equivalent Production

	<u>Direct Materials</u>	<u>Conversion Costs</u>	<u>(Computations)</u>
Units completed and transferred	42,000	42,000	
- Beginning units in process	<u>6,000</u>	<u>6,000</u>	
= Units started and completed	36,000	36,000	
+ Amount needed to complete beginning work-in-process inventory	0	4,800	(6,000 × 80%)
+ Ending units in process	<u>9,000</u>	<u>6,750</u>	(9,000 × 75%)
Total equivalent units	<u>45,000</u>	<u>47,550</u>	

Costs to Account For

	<u>Total</u> <u>Cost</u>	\div	<u>Equivalent</u> <u>Production</u>	$=$	<u>Equivalent</u> <u>Unit Cost</u>
Work-in-process inventory— beginning	\$ 16,000				
Costs added during period:					
Direct materials	200,000		45,000		\$4.44444
Direct labor	100,000		47,550		2.10305
Factory overhead	<u>90,000</u>		47,550		<u>1.89274</u>
Total costs to account for	<u><u>\$406,000</u></u>				<u><u>\$8.44023</u></u>

Costs Accounted For

Transferred to Department 2:

From beginning inventory:

Inventory cost	\$16,000				
Direct labor (6,000 × \$2.10305 × 80%)	10,095				
Factory overhead (6,000 × \$1.89274 × 80%)	<u>9,085</u>		\$ 35,180		

From current production:

Units started and completed

Total transferred (36,000 ×

\$8.44023)

303,848

Work-in-process inventory—
ending:

Direct materials (9,000 ×

\$4.44444)

\$40,000

Direct labor (9,000 ×

\$2.10305 × 75%)

14,196

Factory overhead (9,000 ×

\$1.89274 × 75%)

12,776

66,972

Total costs accounted for

\$406,000

(b)

Nan Corporation
Cost of Production Report, Department 2
FIFO Costing Method

Quantities

Units to account for:

Beginning units in process	8,000	
Received from preceding department	<u>42,000</u>	<u>50,000</u>

Units accounted for:

Units transferred to finished goods inventory	45,000	
Ending units in process	<u>5,000</u>	<u><u>50,000</u></u>

Equivalent Production

	<u>Direct</u> <u>Materials</u>	<u>Conversion</u> <u>Costs</u>	<u>(Computations)</u>
Units completed and transferred	45,000	45,000	
- Beginning units in process	<u>8,000</u>	<u>8,000</u>	
= Units started and completed	37,000	37,000	
+ Amount needed to complete beginning work-in-process inventory	0	2,400	(8,000 × 30%)
+ Ending units in process	<u>5,000</u>	<u>2,000</u>	(5,000 × 40%)
Total equivalent units	<u><u>42,000</u></u>	<u><u>41,400</u></u>	

Costs to Account For

	Units	Total Cost	÷	Equivalent Production	=	Equivalent Unit Cost
Costs from preceding department and prior period:						
Work-in-process inventory--beginning	8,000	\$ 83,720				
Transferred in during period:	42,000	339,028*		42,000		\$ 8.0721
	50,000					
Costs added by department:						
Direct materials		0				
Direct labor		150,000		41,400		3.6232
Factory overhead		120,000		41,400		2.8986
Total costs to account for		\$692,748				\$14.5939

* Costs transferred in:

From beginning inventory: \$ 35,180

From current production: 303,848

\$339,028

\$339,028

Costs Accounted For

Transferred to finished goods inventory:		
From beginning inventory		
Inventory cost	\$83,720	
Direct labor (8,000 × \$3.6232 × 30%)	8,696	
Factory overhead (8,000 × \$2.8986 × 30%)	<u>6,956</u>	\$ 99,372
From current production:		
Units started and completed (37,000 × \$14.5939)		<u>539,974</u>
Total transferred		\$639,346
Work-in-process inventory—ending:		
Costs from preceding department (5,000 × \$8.0721)	\$40,361	
Direct labor (5,000 × \$3.6232 × 40%)	7,246	
Factory overhead (5,000 × \$2.8986 × 40%)	<u>5,797</u>	53,404
Less: rounding difference		<u>(2)</u>
Total costs accounted for		<u><u>\$692,748</u></u>

5.7 Normal Spoilage. At the Stalle Pretzel Co., inspection for spoilage occurs when units are complete. Company policy is to treat spoilage as a separate element of cost. Using the following information, compute spoilage cost for Department 2.

Units transferred in from Department 1	50,000
Normal spoilage	500
Unit cost of units transferred in	\$1.20
Unit costs for Department 2:	
Direct materials	\$1.50
Direct labor	.75
Factory overhead applied	.50

SOLUTION

Computation of spoilage cost:

Transferred-in equivalent unit cost from Department 1 (500 × \$1.20)	\$600
Cost added by Department 2:	
Direct materials (500 × \$1.50)	750
Direct labor (500 × \$0.75)	375
Factory overhead (500 × \$0.50)	250
Total spoilage cost	\$1,975

Chapter 6

By-Product and Joint Product Costing

6.1 JOINT COSTS

The nature of by-products and joint products is such that they contain an element called joint costs. *Joint costs* are those incurred up to the point in a given process where individual products can be identified. In the case of by-products, this is the point at which the main product and its associated by-products emerge. For joint products, it is the point at which separate products having relatively equal sales values can be identified. In both cases, the stage of production at which separate products are identifiable is known as the *split-off point*.

6.2 DIFFICULTIES ASSOCIATED WITH JOINT COSTS

The two major difficulties inherent in joint costs are as follows: (1) *True joint costs are indivisible*; that is, they are not specifically identified with any of the products being simultaneously produced. Thus, the total of these costs must be allocated to individual products on some logical basis. For example, a sample of ore usually contains a variety of minerals (i.e., iron, lead, zinc, etc.). These minerals are joint products in their raw state; until they are extracted by ore reduction, the costs of locating, mining, and processing are properly considered joint costs.

(2) *Joint costs are frequently confused with common costs*. Common costs are those incurred to produce products simultaneously, but each of the products could have been produced separately. The difference here is that joint costs are indivisible while common costs are divisible. That is, the various products resulting from common costs could have each been obtained separately, so common costs can be allocated on the basis of relative usage.

6.3 BY-PRODUCTS DEFINED

By-products are products of limited sales value produced simultaneously with a product of greater sales value. The *main product*, as it is called, is generally produced in much greater quantities than the by-products.

By-products generally fall into one of two categories: (1) those that are sold in the same form as originally produced (revenue recognized when sold), and (2) those that undergo further processing before sale (revenue recognized when produced).

6.4 ACCOUNTING FOR BY-PRODUCTS

By-products are of secondary importance; therefore, cost allocation differs from that of joint products.

The costing of by-products falls into one of two categories:

(1) Category 1—By-Products Are Recognized When “Sold.” By-products are considered to be of little importance, so no production costs are allocated to them. However, net by-product income (which is by-product income less actual additional processing costs and marketing and administration expenses) is shown on the income statement in one of two ways: (A) As an *addition to income*, either

- (1) as part of other sales or
- (2) as other income

(B) As a *deduction from cost of goods sold* of the main product **(2) Category 2—By-Products Are Recognized When “Produced.”** By-products are considered important and the net by-product income is significant. Therefore, production costs are allocated to by-products.

On the income statement, the production costs of the main products *produced* are reduced by the expected value of the by-products *produced*. (*Note*: the calculations are performed on units produced, not units sold.) The amount deducted from production costs is computed in one of two ways: (A) *Net Realizable Value Method*. The expected sales value of the by-product produced is reduced by the expected additional processing costs and marketing and administrative expenses.

(B) *Reversal Cost Method*. The expected sales value of the by-product is reduced by the expected additional processing costs and normal gross profit of the by-product (or by the marketing and administrative expenses and net income).

In doing this computation (revenue less additional costs less gross profit), the amount remaining represents the portion of joint costs allocated to the by-product.

Upon the sale of the by-product, the inventory account must be reduced and the cost of by-products sold must be recognized.

This is the only method where a portion of the joint costs is actually allocated to the by-product. Management should utilize this method when a by-product is considered significant.

EXAMPLE 1

Costs

	Production Costs	Marketing and Administrative	Sales Revenue
Main product and by-product— Department 1	\$150,000	\$21,000	\$300,000
By-product—Department 2 (additional processing costs)	<u>4,500</u>	<u>3,000</u>	<u>21,000</u>
Total	<u><u>\$154,500</u></u>	<u><u>\$24,000</u></u>	<u><u>\$321,000</u></u>

Units

	Produced	Sold	Ending
Main product	40,000	35,000	5,000
By-product	20,000	10,000	10,000

The expected gross profit rate for by-products is 40%. The by-product emerges at the end of processing in Department 1 (split-off point) and is transferred to Department 2, where additional processing is performed.

Category 1

(A) *Addition to income*

(1) *As part of other sales*

Sales:

Main product		\$300,000
By-product		<u>13,500 (a)</u>
Total sales		\$313,500

Cost of main product sold:

Total production costs (Dept. 1)	\$150,000	
Less: Ending inventory	<u>18,750 (b)</u>	
Total cost of main product sold		<u>131,250</u>

Gross profit \$182,250

Less: Marketing and administrative expenses of main product 21,000

Net income \$161,250

(2) *As other income*

Sales (main product)		\$300,000
Cost of main product sold:		
Total production costs (Dept. 1)	\$150,000	
Less: Ending inventory	<u>18,750 (b)</u>	
Total cost of main product sold		<u>131,250</u>
Gross profit		\$168,750
Less: Marketing and administrative expenses of main product		<u>21,000</u>
Income from operations		\$147,750
Other income:		
Net by-product income		<u>13,500 (a)</u>
Net income		<u><u>\$161,250</u></u>

(B) *Deduction from cost of goods sold of main product*

Sales (main product)		\$300,000
Cost of main product sold:		
Total production costs (Dept. 1)	\$150,000	
Less: Ending inventory	<u>18,750 (b)</u>	
Total cost of main product sold	\$131,250	
Less: Net by-product income	<u>13,500 (a)</u>	<u>117,750</u>
Gross profit		\$182,250
Less: Marketing and administrative expenses of main product		<u>21,000</u>
Net income		<u><u>\$161,250</u></u>

(a) *By-product net income* = \$21,000 sales revenue - \$4,500 additional processing costs - \$3,000 marketing and administrative expense = \$13,500.

(b) *Main product ending inventory* = \$150,000 ÷ 40,000 units = \$3.75 per unit × 5,000 units = \$18,750.

Category 2

(A) *Net realizable value method*

Sales (main product)		\$300,000
Cost of main products sold:		
Total production costs (Dept. 1)	\$150,000	
Less: Value of by-product produced	<u>34,500 (c)</u>	
Net production costs	\$115,500	
Less: Ending inventory	<u>14,450 (d)</u>	<u>101,050</u>
Gross profit		\$198,950
Less: Marketing and administrative expenses of main product		<u>21,000</u>
Net income		<u><u>\$177,950</u></u>

(B) *Reversal cost method*

Sales:			
Main product		\$300,000	
By-product		<u>21,000</u>	\$321,000
Cost of main product and by-product sold:			
Production costs:			
Main product	\$129,300 (e)		
By-product	<u>25,200 (f)</u>	\$154,500	
Less: Ending inventory			
Main product	\$ 16,163 (g)		
By-product	<u>10,350 (h)</u>	<u>26,513</u>	<u>127,987</u>
Gross profit			\$193,013
Less: Marketing and administrative expenses:			
Main product		\$ 21,000	
By-product		<u>3,000</u>	<u>24,000</u>
Net income			<u><u>\$169,013</u></u>

(c) *Value of by-product produced* = by-product sales of \$21,000 ÷ 10,000 units sold = \$2.10 per unit × 20,000 units produced = \$42,000 – \$4,500 additional processing costs – \$3,000 marketing and administrative costs = \$34,500.

(d) *Main product ending inventory* = net production costs of \$115,500 ÷ 40,000 units = \$2.89 per unit × 5,000 units = \$14,450.

(e) *Production cost of main product*

Total production costs—Department 1				\$150,000
Less: Joint costs applicable to by-products produced:				
Expected sales value (\$2.10 per unit × 20,000 units)		\$42,000		
Less: Additional processing costs	\$ 4,500			
Expected gross profit (40% of \$42,000)	<u>16,800</u>	<u>21,300</u>	<u>20,700</u>	
Production cost of main product				<u>\$129,300</u>

(f) *Production cost of by-product* = \$20,700 joint cost applicable to by-product (above) + \$4,500 additional processing costs = \$25,200.

(g) *Main product ending inventory* = \$129,300 production costs ÷ 40,000 units produced = \$3,232.5 per unit × 5,000 units = \$16,163

(h) *By-product ending inventory* = \$20,700 production costs ÷ 20,000 units produced = \$1,035 per unit × 10,000 units = \$10,350.

6.5 JOINT PRODUCTS DEFINED

The term *joint products* refers to individual products, each of significant sales value, produced simultaneously as a result of a common process or series of processes. *Joint product costs* are those which arise in the course of such common processes involving common raw materials. Note that joint product costs are inherently indivisible, having been incurred simultaneously for all products, and not for each product individually.

The basic characteristics of joint products are as follows: (1) an unavoidable physical relationship which requires simultaneous, common processing, (2) a split-off point at which separate products emerge to be sold or further processed, and (3) none of the joint products are significantly greater in value than other joint products' values. Joint products manufacturing is found in the meat-packing industry, in natural resource refining industries, and in those where raw materials must be graded before processing.

6.6 ACCOUNTING FOR JOINT PRODUCTS

A portion of joint costs must be allocated to each of the joint products. Following are the methods commonly used: (1) *Market Value at Split-Off Point Method*

The allocation of joint costs on the basis of market or sales values of the individual products is the most popular allocation method. Advocates of this method argue that a direct relationship exists

between cost and selling price, namely, that the selling price of a product is determined primarily by the production cost. This method is used when the market value is known.

$$\text{Joint cost allocation of each product} = \frac{\text{Total market value of each product}^*}{\text{Total market value of all products}^{**}} \times \text{Joint costs}$$

* Total market value of *each* product = Units produced of *each* product \times Unit market value of *each* product
** Total market value of *all* products = Sum of all the total market values of *each* product

EXAMPLE 2

Joint Cost Allocation
Market Value at Split-Off Point Method
Total Joint Costs: \$310,000

Joint Products

	A	B	C
Units produced	40,000	80,000	20,000
Market value at split-off point:			
Unit	\$4.00	\$5.00	\$3.00
Total	\$160,000	\$400,000	\$60,000

$$\text{Product A: } \frac{\$160,000}{\$620,000*} \times \$310,000 = \$80,000$$

$$\text{Product B: } \frac{\$400,000}{\$620,000} \times \$310,000 = 200,000$$

$$\text{Product C: } \frac{\$60,000}{\$620,000} \times \$310,000 = \underline{\underline{30,000}}$$

$$\text{Total Joint Costs } \underline{\underline{\$310,000}}$$

* Total market value of all products:

$$\$160,000 + \$400,000 + \$60,000 = \$620,000$$

(2) Net Realizable Value Method

When the market value of a joint product cannot be readily determined at the split-off point, as, for example, when a product requires additional processing before it can be sold, a *hypothetical* market value at the split-off point is calculated. The hypothetical market value is determined by subtracting

the cost of additional processing from the market value of the completed product. The total cost of each product (allocation of joint costs + after split-off processing costs) is computed as follows.

$$\begin{aligned} & \text{Total cost allocation of each product} = \\ & \left(\frac{\text{Total hypothetical market value of each product at split-off point}^*}{\text{Total hypothetical market value of all products at split-off point}^{**}} \times \text{Joint costs} \right) \\ & + \text{After split-off processing costs of each product} \end{aligned}$$

- * Total hypothetical market value of *each* product at split-off point = (Units produced of *each* product × Hypothetical market value of *each* product) – After split-off processing costs of *each* product.
- ** Total hypothetical market value of *all* products at split-off point = Sum of all the total hypothetical market values of *each* product.

EXAMPLE 3

Joint Cost Allocation
Net Realizable Value Method
Total Joint Costs: \$310,000

Joint Products

	A	B	C
Number of units produced	40,000	80,000	20,000
Market value <i>after</i> further processing (no market value at split-off is available)			
Unit	\$4.00	\$5.00	\$3.00
Total	\$160,000	\$400,000	\$60,000
Additional processing costs after split-off	\$8,000	\$12,000	\$6,000

$$\text{Product A: } \frac{\$160,000 - \$8,000}{\$594,000^*} \times \$310,000 = \$79,327$$

$$\text{Product B: } \frac{\$400,000 - \$12,000}{\$594,000} \times \$310,000 = 202,492$$

$$\text{Product C: } \frac{\$60,000 - \$6,000}{\$594,000} \times \$310,000 = \underline{\underline{28,182}}$$

$$\text{Total Joint Costs } \underline{\underline{\$310,001^{**}}}$$

* Total hypothetical market value of all products:

$$(\$160,000 - \$8,000) + (\$400,000 - \$12,000) + (\$60,000 - \$6,000) = \$594,000$$

** Rounding difference

(3) *Physical Output Method*

Under this method, the quantity of output (expressed in units) is used as the basis for allocating joint costs. Since the quantity of output of all the joint products must be stated in the same terms, a common denominator (for example, quantity/ton) must be determined when the measurement basis of output varies from product to product. The joint cost allocated to each product under this method is computed by using the following formula:

$$\text{Joint cost allocation of each product} = \frac{\text{Total units of each product}}{\text{Total units of all products}^*} \times \text{Joint costs}$$

* Total units of all products = Sum of all units produced

EXAMPLE 4

The information presented in [Example 3](#) is used here to illustrate the allocation of joint costs under the physical output method.

$$\begin{array}{l} \text{Product A: } \frac{40,000}{140,000^*} \times \$310,000 = \$ 88,571 \\ \text{Product B: } \frac{80,000}{140,000} \times \$310,000 = 177,143 \\ \text{Product C: } \frac{20,000}{140,000} \times \$310,000 = \underline{44,286} \\ \text{Total } \underline{\underline{\$310,000}} \end{array}$$

* Total units of all products:

$$40,000 + 80,000 + 20,000 = 140,000$$

Solved Problems

6.1 By-product Profit Determination. The following income statement of the Lepolstat Manufacturing Company treats revenues from sales of by-products as other income. Determine the gross profit, the profit from operations, and the net profit by recognizing revenue from sales of by-products as (a) other sales revenue, (b) a deduction from cost of goods sold, and (c) other income. (Round to three places.)

Sales (main product, 10,000 units @ \$6)		\$60,000
Cost of Goods Sold		
Production Costs (14,000 units @ \$3)	\$42,000	
Ending Inventory (4,000 units @ \$3)	<u>12,000</u>	<u>30,000</u>
Gross Profit		\$30,000
Marketing and Administrative Expenses		<u>2,000</u>
Income from Operations		\$28,000
Other Income		
Net By-product Income		<u>3,000</u>
Net Income		<u><u>\$31,000</u></u>

SOLUTION

(a) Other Sales Revenue

Sales:

Main product	\$60,000
By-product	<u>3,000</u>
Total sales	\$63,000

Cost of main product sold:

Total production costs	\$42,000
Less: Ending inventory	<u>12,000</u>
Total cost of main product sold	<u>30,000</u>

Gross profit \$33,000

Less: Marketing and administrative expenses of main product 2,000

Net income \$31,000

(b) Deduction from Cost of Goods Sold

Sales (main product)		\$60,000
Cost of main product sold:		
Total production costs	\$42,000	
Less: Ending inventory	<u>12,000</u>	
Total cost of main product sold	\$30,000	
Less: Net by-product income	<u>3,000</u>	<u>27,000</u>
Gross profit		\$33,000
Less: Marketing and administrative expenses of main product		<u>2,000</u>
Net income		<u><u>\$31,000</u></u>

(c) Other Income

Sales (main product)		\$60,000
Cost of main product sold:		
Total production costs	\$42,000	
Less: Ending inventory	<u>12,000</u>	
Total cost of main product sold		<u>30,000</u>
Gross profit		\$30,000
Less: Marketing and administrative expenses of main product		<u>2,000</u>
Income from operations		\$28,000
Other income:		
Net by-product income		<u>3,000</u>
Net income		<u><u>\$31,000</u></u>

6.2 By-products: Reversal Cost Method. The Whitcomb Industrial Corporation manufactures one main product and one by-product. During one period of production, the following data were compiled:

	Main Product	By-Product X
Sales	\$300,000	\$11,800
Processing costs before separation	120,000	
Processing costs after separation		3,600
Marketing and administrative expenses	20,000	2,200
Units sold	30,000	1,000

There are no beginning or ending inventories. The corporation allows a 20% gross profit for Product X

Calculate net income using the reversal cost method.

SOLUTION

Sales:		
Main product	\$300,000	
By-product	<u>11,800</u>	\$311,800
Cost of main product and by-product sold:		
Production costs:		
Main product	\$114,160 (a)	
By-product	<u>9,440 (b)</u>	<u>123,600</u>
Gross profit		\$188,200
Less: Marketing and administrative expenses:		
Main product	\$ 20,000	
By-product	<u>2,200</u>	<u>22,200</u>
Net income		<u><u>\$166,000</u></u>

(a) Production cost of main product:

Total production costs		\$120,000
Less: Joint costs applicable to by-products produced:		
Expected sales value (\$11.80 per unit × 1,000 units)		\$11,800
Less: Additional processing costs	\$3,600	
Expected gross profit (20% of \$11,800)	<u>2,360</u>	<u>5,960</u>
Production cost of main product		<u><u>\$114,160</u></u>

(b) *Production cost of by-product:*

\$5,840 joint cost applicable to by-product (above) + \$3,600 additional processing costs = \$9,440.

6.3 By-products: Net Realizable Value Method. Using the information in Problem 6.2. compute net income using the net realizable value method.

SOLUTION

Sales (main product)		\$300,000
Cost of main products sold:		
Total production costs	\$120,000	
Less: Value of by-product produced	<u>6,000 (a)</u>	
Net production costs		<u>114,000</u>
Gross profit		\$186,000
Less: Marketing and administrative expenses of main product		<u>20,000</u>
Net income		<u><u>\$166,000</u></u>

(a) *Value of by-product produced* = \$11.80 per unit × 1,000 units produced = \$11,800 – \$3,600 additional processing costs – \$2,200 marketing and administrative expense = \$6,000.

6.4 Joint Costs: Net Realizable Value Method. The Bounceback Manufacturing Company manufactures two products, Realrubber and Fakerubber, from the same material. The material costs \$0.95 per pound and must pass through two departments. In Department 1, the material is split into Realrubber and Fakerubber. Realrubber requires no further processing; Fakerubber must be processed further in Department 2. The costs below pertain to the year ended December 31, 19X8.

Department	Direct Materials	Direct Labor	Factory Overhead	Total
1	\$144,000	\$21,000	\$15,000	\$180,000
2	...	10,000	18,000	28,000
Totals	<u>\$144,000</u>	<u>\$31,000</u>	<u>\$33,000</u>	<u>\$208,000</u>

Product	Pounds Sold	Pounds of Finished Goods, Ending Inventory	Sales
Realrubber	30,000	15,000	\$ 52,500
Fakerubber	45,000	...	150,750

There were no materials on hand at year end.

Compute the allocation of joint costs between Realrubber and Fakerubber.

SOLUTION

$$\text{Unit price of Realrubber} = \frac{\text{Sales}}{\text{Pounds sold}} = \frac{\$52,500}{30,000} = \$1.75$$

The market value of Realrubber at the split-off point is computed as follows:

Sales	\$52,500
Ending inventory (15,000 lbs @ \$1.75)	<u>26,250</u>
Market value at split-off	<u>\$78,750</u>

Hypothetical market value of Fakerubber:

Market value at split-off	\$150,750
Additional processing costs	<u>- 28,000</u>
Hypothetical market value	<u>\$122,750</u>

Allocation of joint costs of \$180,000:

$$\text{Realrubber: } \frac{\$78,750}{\$201,500 (a)} \times \$180,000 = \$ 70,347$$

$$\text{Fakerubber: } \frac{\$122,750}{\$201,500 (a)} \times \$180,000 = \$109,653$$

$$(a) \$78,750 + \$122,750 = \$201,500$$

6.5 Joint Costs: Market Value Method. Using the information from Problem 6.4, and assuming that the actual market value of Fakerubber is \$165,000, compute the joint cost allocation.

SOLUTION

$$\text{Realrubber } \frac{\$52,500}{\$217,500} \times \$180,000 = \$ 43,448$$

$$\text{Fakerubber } \frac{\$165,000}{\$217,500} \times \$180,000 = \$136,552$$

6.6 Joint Costs: Physical Output Method. Using the information from Problem 6.4, compute the joint cost allocation using the physical output method.

SOLUTION

$$\text{Realrubber } \frac{30,000}{75,000} \times \$180,000 = \$ 72,000$$

$$\text{Fakerubber } \frac{45,000}{75,000} \times \$180,000 = \$108,000$$

Chapter 7

The Master Budget

7.1 NATURE OF THE BUDGET

A budget is a quantitative expression of management objectives and a tool used to analyze progress toward those objectives. An effective budget should be properly coordinated with management and accounting systems. Budgets may be short-term (1 year or less) or long-term (greater than 1 year).

7.2 DEVELOPING THE MASTER BUDGET

The master budget encompasses all functions and management levels, although the approach to formulating the budget may differ from company to company. Two opposite and extreme views of how to develop a master budget are the *top management approach* (input comes *only* from top officers) and the *grass roots approach* (all levels participate in forecasting). Irrespective of who is involved in providing input, the following sequence is generally followed in constructing a master budget: (1) Sales budget

- (2) Production budget
- (3) Direct materials purchase budget
- (4) Direct materials usage budget
- (5) Direct labor budget
- (6) Factory overhead budget
- (7) Ending inventories budget
- (8) Cost of goods sold budget
- (9) Selling expense budget
- (10) Administrative expense budget
- (11) Budgeted income statement
- (12) Cash budget
- (13) Budgeted balance sheet

The following balance sheet and additional information will be used to prepare the master budget for the Coates Corporation for the first quarter of 19XX: *Coates Corporation*

Balance Sheet
January I, 19XX

Assets

<i>Current</i>			
Cash		\$ 20,700	
Accounts receivable		132,930	
Materials		6,600	
Finished goods		<u>79,800</u>	
Total			\$ 240,030
<i>Plant</i>			
Equipment	\$ 75,000		
Less: Accumulated depreciation	<u>7,140</u>	\$ 67,860	
Buildings	\$800,000		
Less: Accumulated depreciation	<u>48,460</u>	<u>751,540</u>	
Total			<u>819,400</u>
Total assets			<u><u>\$1,059,430</u></u>

Liabilities and Stockholders' Equity

Liabilities

Accounts payable \$ 10,300

Stockholders' Equity

Common stock \$10 par; 90,000 shares

issued and outstanding 900,000

Retained earnings 149,130

Total liabilities and stockholders' equity \$1,059,430

Forecasted Sales by Territory

Territory	Units		
	January	February	March
1	300	450	200
2	280	500	170
3	350	550	300

Variable Expenses (% of Total Sales Dollars)

Commissions	5%
Travel	3%
Advertising	7%

Fixed Expenses per Month

Indirect materials	\$2,000
Indirect labor	900
Maintenance	1,200
Heat and light	300
Power	200
Insurance	270
Depreciation (60% equipment; 40% building)	1,350
Taxes	600
Sales salaries	1,400
Executive salaries	2,000
Administrative expenses	1,500
Selling expenses	1,300

Desired Finished Goods Inventories* (Units)

January 1	950
January 31	900
February 28	980
March 31	1,100

* *Assumption:* All ending inventories are at standard cost.

Other Data

Average sales price	\$150 per unit
Materials cost	\$25 per unit
December purchases	\$25,750
Desired direct materials ending inventory	30% of next month's production (this policy was in effect last year)
Production, April	600 units
Direct labor hours	3 per unit
Direct materials	1 unit per product
Labor cost	\$12.25 per hour
Income tax rate	50%

Variable Factory Overhead Rates per Direct Labor Hour

Indirect labor	\$1.20
Maintenance	1.30
Power	1.55
Payroll taxes	1.10

Construction of the master budget begins with the sales budget.

7.3 SALES BUDGET

A sales forecast is the basis upon which the sales budget and all other budgets are developed. The formula used to develop a sales budget in dollars is: Sales budget (units) \times Sales price per unit

EXAMPLE 1

Coates Corporation
Sales Budget
First Quarter, 19XX

Units

Territory	Jan.	Feb.	Mar.	Total
1	300	450	200	950
2	280	500	170	950
3	<u>350</u>	<u>550</u>	<u>300</u>	<u>1,200</u>
Total	<u>930</u>	<u>1,500</u>	<u>670</u>	<u>3,100</u>

Dollars*

1	\$ 45,000	\$ 67,500	\$ 30,000	\$142,500
2	42,000	75,000	25,500	142,500
3	<u>52,500</u>	<u>82,500</u>	<u>45,000</u>	<u>180,000</u>
Total	<u>\$139,500</u>	<u>\$225,000</u>	<u>\$100,500</u>	<u>\$465,000</u>

* Sales price = \$150 per unit

7.4 PRODUCTION BUDGET

The production budget can be developed with the information provided by the sales budget and the inventory estimates. Essentially it is the sales budget adjusted for changes in inventory. The formula used to compute the production requirement for the quarter is: Sales budget (units) + desired ending inventory (units) – beginning inventory (units) **EXAMPLE 2**

*Coates Corporation
Production Budget
First Quarter, 19XX*

Units

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Total</u>
Sales budget	930	1,500	670	3,100
Add: Desired ending inventory	<u>900</u>	<u>980</u>	<u>1,100</u>	<u>1,100</u>
Subtotal	1,830	2,480	1,770	4,200
Less: Beginning inventory	<u>950</u>	<u>900</u>	<u>980</u>	<u>950</u>
Production required	<u><u>880</u></u>	<u><u>1,580</u></u>	<u><u>790</u></u>	<u><u>3,250</u></u>

7.5 DIRECT MATERIALS PURCHASE BUDGET

The required purchases are a function of each period's production, beginning inventory level, and desired ending inventory level. The formulas used are: Purchase of direct materials required (units) = Production budget (units) + Desired ending inventory (units) - Beginning inventory (units)
= Purchase of direct materials required (units) × Purchase cost per unit
= Direct materials purchase cost **EXAMPLE 3**

Coates Corporation
Direct Materials Purchase Budget
First Quarter, 19XX

	Jan.	Feb.	Mar.	Total
Production units required	880	1,580	790	3,250
Add: Desired ending inventory*	<u>474</u>	<u>237</u>	<u>180**</u>	<u>180</u>
Subtotal	1,354	1,817	970	3,430
Less: Beginning inventory***	<u>264</u>	<u>474</u>	<u>237</u>	<u>264</u>
Purchases required	1,090	1,343	733	3,166
Cost per unit	<u>× \$25</u>	<u>× \$25</u>	<u>× \$25</u>	<u>× \$25</u>
Purchase cost	<u>\$27,250</u>	<u>\$33,575</u>	<u>\$18,325</u>	<u>\$79,150</u>

* Desired direct materials ending inventory is 30% of the *next* month's production.

** 600 units (April production) × 30% = 180 units.

*** Beginning direct materials inventory is 30% of the *same* month's production (the same as the desired ending inventory of the previous month).

7.6 DIRECT MATERIALS USAGE BUDGET

The usage budget (in units and usage cost) is based upon the standard costing systems requirements (specifically, the number of direct material units required to produce one unit of finished product). The formula used to determine direct materials usage cost is: Direct materials required (units) × Materials unit cost

EXAMPLE 4

Coates Corporation
Direct Materials Usage Budget
First Quarter, 19XX

	Jan.	Feb.	Mar.	Total
Direct materials required* (units)	880	1,580	790	3,250
Materials unit cost	<u>× \$25</u>	<u>× \$25</u>	<u>× \$25</u>	<u>× \$25</u>
Direct materials usage cost	<u><u>\$22,000</u></u>	<u><u>\$39,500</u></u>	<u><u>\$19,750</u></u>	<u><u>\$81,250</u></u>

* One unit of direct materials is needed for each unit of production. Hence, the amounts are the same as the production units required (Example 2).

7.7 DIRECT LABOR BUDGET

Direct labor standards are usually based on time studies conducted by engineers. Indirect labor costs are included in the factory overhead budget. The formula used to determine direct labor cost is:
 Production units required × Direct labor hours per unit × Rate per hour **EXAMPLE 5**

Coates Corporation
Direct Labor Budget
First Quarter, 19XX

	Jan.	Feb.	Mar.	Total
Production units required	880	1,580	790	3,250
	<u>× 3</u>	<u>× 3</u>	<u>× 3</u>	<u>× 3</u>
Direct Labor hours (3 per unit)	2,640	4,740	2,370	9,750
Rate per hour	<u>× \$12.25</u>	<u>× \$12.25</u>	<u>× \$12.25</u>	<u>× \$12.25</u>
Direct labor cost	<u><u>\$ 32,340</u></u>	<u><u>\$ 58,065</u></u>	<u><u>\$29,032.50</u></u>	<u><u>\$119,437.50</u></u>

7.8 FACTORY OVERHEAD BUDGET

Factory overhead costs are budgeted for various levels of production. Total costs are separated into

fixed components (assigned by dollar values) and variable components (assigned by rates and based on direct labor hours). The formula used to determine total factory overhead is: Fixed overhead per item + (total budgeted direct labor hours × variable expense rate per hour) **EXAMPLE 6**

Coates Corporation
Factory Overhead Budget
January, 19XX

Direct Labor Hours: 2,640

Type of Expense	Fixed	Variable	Total
Indirect materials	\$2,000		\$ 2,000
Indirect labor	900	\$3,168 (a)	4,068
Maintenance	1,200	3,432 (b)	4,632
Heat and light	300		300
Power	200	4,092 (c)	4,292
Insurance	270		270
Depreciation	1,350		1,350
Taxes	600		600
Payroll taxes		2,904 (d)	2,904
Total	\$6,820	\$13,596	\$20,416

(a) $2,640 \times \$1.20 = \$3,168.$

(b) $2,640 \times \$1.30 = \$3,432.$

(c) $2,640 \times \$1.55 = \$4,092.$

(d) $2,640 \times \$1.10 = \$2,904.$

Coates Corporation
Factory Overhead Budget
February, 19XX

Direct Labor Hours: 4,740

Type of Expense	Fixed	Variable	Total
Indirect materials	\$2,000		\$ 2,000
Indirect labor	900	\$5,688 (a)	6,588
Maintenance	1,200	6,162 (b)	7,362
Heat and light	300		300
Power	200	7,347 (c)	7,547
Insurance	270		270
Depreciation	1,350		1,350
Taxes	600		600
Payroll taxes		5,214 (d)	5,214
Total	\$6,820	\$24,411	\$31,231

(a) $4,740 \times \$1.20 = \$5,688.$

(b) $4,740 \times \$1.30 = \$6,162.$

(c) $4,740 \times \$1.55 = \$7,347.$

(d) $4,740 \times \$1.10 = \$5,214.$

Coates Corporation
Factory Overhead Budget
March, 19XX

Direct Labor Hours: 2,370

Type of Expense	Fixed	Variable	Total
Indirect materials	\$2,000		\$ 2,000.00
Indirect labor	900	\$2,844.00 (a)	3,744.00
Maintenance	1,200	3,081.00 (b)	4,281.00
Heat and light	300		300.00
Power	200	3,673.50 (c)	3,873.50
Insurance	270		270.00
Depreciation	1,350		1,350.00
Taxes	600		600.00
Payroll taxes		2,607.00 (d)	2,607.00
Total	\$6,820	\$12,205.50	\$19,025.50

(a) $2,370 \times \$1.20 = \$2,844.00.$

(b) $2,370 \times \$1.30 = \$3,081.00.$

(c) $2,370 \times \$1.55 = \$3,673.50.$

(d) $2,370 \times \$1.10 = \$2,607.00.$

Coates Corporation
Factory Overhead Budget
First Quarter, 19XX

Month	Amount
January	\$20,416.00
February	31,231.00
March	<u>19,025.50</u>
Total	<u><u>\$70,672.50</u></u>

7.9 ENDING INVENTORIES BUDGET

Budgeted inventory amounts of direct materials and finished goods at month's end are needed for the financial statements. Ending inventory cost is computed as follows: Ending inventory (units) × Standard cost per unit

EXAMPLE 7

Coates Corporation
Ending Inventories Budget
First Quarter, 19XX

	Ending Inventory (Units)	Standard Cost per Unit	Total Cost
January	900	\$84	\$ 75,600
February	980	\$84	\$ 82,320
March	1,100	\$84	<u>\$ 92,400</u>
			<u><u>\$250,320</u></u>

Note: The approximate standard unit cost for finished goods is the average of the total manufacturing costs for one unit, calculated as follows:

$$\frac{\text{Direct materials usage budget} + \text{Direct labor budget} + \text{Factory overhead budget}}{\text{Production budget}}$$

For the Coates Corp. this translates into:

$$\frac{\$81,250 \text{ (Example 4)} + \$119,437.50 \text{ (Example 5)} + \$70,672.50 \text{ (Example 6)}}{880 + 1,580 + 790} = \frac{\$271,360}{3,250} = \$83.495$$

which equals approximately \$84.

7.10 COST OF GOODS SOLD BUDGET

The component parts of this budget are found in previous budgets.

EXAMPLE 8

*Coates Corporation
Cost of Goods Sold Budget
First Quarter, 19XX*

	Jan.	Feb.	Mar.	Total
Direct materials (Example 4)	\$22,000	\$ 39,500	\$ 19,750.00	\$ 81,250.00
Direct labor (Example 5)	32,340	58,065	29,032.50	119,437.50
Factory overhead (Example 6)	<u>20,416</u>	<u>31,231</u>	<u>19,025.50</u>	<u>70,672.50</u>
Total manufacturing costs	\$74,756	\$128,796	\$67,808.00	\$271,360.00
Add: Finished goods, beginning*	(950 × \$84) <u>79,800</u>	(900 × \$84) <u>75,600</u>	(980 × \$84) <u>82,320.00</u>	<u>79,800.00</u>
Subtotal	\$154,556	\$204,396	\$150,128.00	\$351,160.00
Less: Finished goods, ending (Example 7)	<u>75,600</u>	<u>82,320</u>	<u>92,400.00</u>	<u>92,400.00</u>
Cost of goods sold	<u><u>\$78,956</u></u>	<u><u>\$122,076</u></u>	<u><u>\$57,728.00</u></u>	<u><u>\$258,760.00</u></u>

* Calculation: Beginning inventory (Example 2) × Standard cost per unit of finished goods (Example 7).

7.11 SELLING EXPENSE BUDGET

This budget is usually divided into its variable and fixed components; the variable costs fluctuate with sales, and the fixed costs remain constant per month. The formula used is Fixed expenses per item + [Sales dollars × Variable expense rate (%)]

EXAMPLE 9

Coates Corporation
Selling Expense Budget
January, 19XX

Type of Expense	Fixed	Variable	Total
Salaries	\$1,400		\$ 1,400
Commissions		\$ 6,975 (a)	6,975
Travel		4,185 (b)	4,185
Advertising		9,765 (c)	9,765
Selling	<u>1,300</u>		<u>1,300</u>
Total	<u><u>\$2,700</u></u>	<u><u>\$20,925</u></u>	<u><u>\$23,625</u></u>

(a) $5\% \times \$139,500 = \$6,975.$

(b) $3\% \times \$139,500 = \$4,185.$

(c) $7\% \times \$139,500 = \$9,765.$

Coates Corporation
Selling Expense Budget
February, 19XX

Type of Expense	Fixed	Variable	Total
Salaries	\$1,400		\$ 1,400
Commissions		\$11,250 (a)	11,250
Travel		6,750 (b)	6,750
Advertising		15,750 (c)	15,750
Selling	<u>1,300</u>		<u>1,300</u>
Total	<u><u>\$2,700</u></u>	<u><u>\$33,750</u></u>	<u><u>\$36,450</u></u>

(a) $5\% \times \$225,000 = \$11,250.$

(b) $3\% \times \$225,000 = \$ 6,750.$

(c) $7\% \times \$225,000 = \$15,750.$

Coates Corporation
Selling Expense Budget
March, 19XX

Type of Expense	Fixed	Variable	Total
Salaries	\$1,400		\$ 1,400
Commissions		\$ 5,025 (a)	5,025
Travel		3,015 (b)	3,015
Advertising		7,035 (c)	7,035
Selling	<u>1,300</u>		<u>1,300</u>
Total	<u>\$2,700</u>	<u>\$15,075</u>	<u>\$17,775</u>

(a) $5\% \times \$100,500 = \$5,025.$

(b) $3\% \times \$100,500 = \$3,015.$

(c) $7\% \times \$100,500 = \$7,035.$

7.12 ADMINISTRATIVE EXPENSE BUDGET

Administrative expenses are generally fixed in nature; therefore, the budget prepared for one month can be used for every month.

EXAMPLE 10

Coates Corporation
Administrative Expense Budget
Per Month, 19XX

Type of Expense	
Executive salaries	\$2,000
Other administrative expense	<u>1,500</u>
Total	<u>\$3,500</u>

7.13 BUDGETED INCOME STATEMENT

The final result of all the operations budgets, such as those for sales, cost of goods sold, selling expenses, and administrative expenses, is summarized in the budgeted income statement.

EXAMPLE 11

Coates Corporation
Budgeted Income Statement
First Quarter, 19XX

Supporting Budgets	Jan.	Feb.	Mar.	Total
Sales (Example 1)	\$139,500.00	\$225,000.00	\$100,500.00	\$465,000.00
Cost of goods sold (Example 8)	<u>78,956.00</u>	<u>122,076.00</u>	<u>57,728.00</u>	<u>258,760.00</u>
Gross profit (loss)	<u>\$ 60,544.00</u>	<u>\$102,924.00</u>	<u>\$ 42,772.00</u>	<u>\$206,240.00</u>
<i>Operating Expenses</i>				
Selling expenses (Example 9)	\$ 23,625.00	\$ 36,450.00	\$ 17,775.00	\$ 77,850.00
Administrative (Example 10)	<u>3,500.00</u>	<u>3,500.00</u>	<u>3,500.00</u>	<u>10,500.00</u>
Total operating expenses	<u>\$ 27,125.00</u>	<u>\$ 39,950.00</u>	<u>\$ 21,275.00</u>	<u>\$ 88,350.00</u>
Net income before taxes	\$ 33,419.00	\$ 62,974.00	\$ 21,497.00	\$117,890.00
Less: Income taxes (50%)	<u>16,709.50</u>	<u>31,487.00</u>	<u>10,748.50</u>	<u>58,945.00</u>
Net income	<u><u>\$ 16,709.50</u></u>	<u><u>\$ 31,487.00</u></u>	<u><u>\$ 10,748.50</u></u>	<u><u>\$ 58,945.00</u></u>

7.14 CASH BUDGET

Cash budgets are useful for stabilizing a company's cash balances and for keeping these balances reasonably close to continuing cash requirements. To prepare a cash budget, the following information is needed: the beginning cash balance, cash receipts for that period, and cash disbursements for that period.

The estimated amount of cash collections from accounts receivable is based on the cash collection experience of the company. For Coates Corporation a study shows that 10% of the company's current month's credit sales are collected during the same month, as well as 85% of the credit sales made the previous month and 5% of the credit sales made 2 months earlier.

EXAMPLE 12

For this example, assume that all monies due from November sales have been collected by January I, 19XX. Sales figures are as follows:

	Dec.	Jan.	Feb.	Mar.
Total sales	\$153,000	\$139,500	\$225,000	\$100,500
Cash sales	<u>5,300</u>	<u>4,500</u>	<u>8,000</u>	<u>3,500</u>
Credit sales	<u><u>\$147,700</u></u>	<u><u>\$135,000</u></u>	<u><u>\$217,000</u></u>	<u><u>\$ 97,000</u></u>

*Coates Corporation
Cash Receipts Forecast
First Quarter, 19XX*

Collections

Month of Sale	Credit Sales	Collections		
		Jan.	Feb.	Mar.
December	\$147,700			
85%		\$125,545		
5%			\$ 7,385	
January	135,000			
10%		13,500		
85%			114,750	
5%				\$ 6,750
February	217,000			
10%			21,700	
85%				184,450
March	97,000			
10%				9,700
Total		<u>\$139,045</u>	<u>\$143,835</u>	<u>\$200,900</u>

Cash disbursements are based on payments for purchases of direct materials. Payments are 60% in the month of purchase and 40% in the next month.

EXAMPLE 13

Coates Corporation
Cash Disbursements Forecast—Direct Materials

First Quarter, 19XX

Accounts Payable

	Purchases	Jan.	Feb.	Mar.
December	\$25,750			
40%		\$10,300		
January	27,250			
60%		16,350		
40%			\$10,900	
February	33,575			
60%			20,145	
40%				\$13,430
March	18,325			
60%				10,995
Total		<u>\$26,650</u>	<u>\$31,045</u>	<u>\$24,425</u>

To prepare the cash budget, the following information is needed: (1) Cash balance, beginning (CBB)

(2) Cash receipts for the period (CR)

(3) Cash disbursements for the period (CD)

The formula then is

$$\text{Cash balance, ending (CBE)} = \text{CBB} + \text{CR} - \text{CD}$$

EXAMPLE 14

Assume that a minimum balance of \$3,000 cash is to be maintained by the company during 19XX.

Coates Corporation
Cash Budget
First Quarter, 19XX

	Jan.	Feb.	Mar.	Quarter
Cash balance, beginning	<u>\$ 20,700.00</u>	<u>\$ 42,354.50</u>	<u>\$ 3,761.50</u>	<u>\$ 20,700.00</u>
<i>Cash Receipts</i>				
Collections on account	\$139,045.00	\$143,835.00	\$200,900.00	\$483,780.00
Cash sales	<u>4,500.00</u>	<u>8,000.00</u>	<u>3,500.00</u>	<u>16,000.00</u>
Total cash receipts	<u>\$143,545.00</u>	<u>\$151,835.00</u>	<u>\$204,400.00</u>	<u>\$499,780.00</u>
Total cash available	<u>\$164,245.00</u>	<u>\$194,189.50</u>	<u>\$208,161.50</u>	<u>\$520,480.00</u>
<i>Cash Disbursements</i>				
Direct materials	\$ 26,650.00	\$ 31,045.00	\$ 24,425.00	\$ 82,120.00
Direct labor	32,340.00	58,065.00	29,032.50	119,437.50
Factory overhead	19,066.00 (a)	29,881.00 (b)	17,675.50 (c)	66,622.50
Selling expenses	23,625.00	36,450.00	17,775.00	77,850.00
Administrative expenses	3,500.00	3,500.00	3,500.00	10,500.00
Income taxes	<u>16,709.50</u>	<u>31,487.00</u>	<u>10,748.50</u>	<u>58,945.00</u>
Total cash disbursements	<u>\$121,890.50</u>	<u>\$190,428.00</u>	<u>\$103,156.50</u>	<u>\$415,475.00</u>
Ending balance	<u><u>\$ 42,354.50</u></u>	<u><u>\$ 3,761.50</u></u>	<u><u>\$105,005.00</u></u>	<u><u>\$105,005.00</u></u>

(a) \$20,416 - \$1,350 depreciation = \$19,066.00.

(b) \$31,231 - \$1,350 depreciation = \$29,881.00.

(c) \$19,025.50 - \$1,350 depreciation = \$17,675.50.

7.15 BUDGETED BALANCE SHEET

Useful for showing a company's financial position, the balance sheet is derived by the formula
 $Assets = Liabilities + Equity$

EXAMPLE 15

Coates Corporation Budgeted Balance Sheet March 31, 19XX

Assets			
<i>Current</i>			
Cash		\$105,005	
Accounts receivable (a)		98,150	
Materials (b)		4,500	
Finished goods (c)		<u>92,400</u>	
Total			\$ 300,055
<i>Plant</i>			
Equipment	\$ 75,000		
Less: Accumulated depreciation (d)	<u>9,570</u>	\$ 65,430	
Building	\$800,000		
Less: Accumulated depreciation (e)	<u>50,080</u>	<u>749,920</u>	
Total			<u>815,350</u>
Total assets			<u><u>\$1,115,405</u></u>

Liabilities and Stockholders' Equity

Liabilities

Accounts payable (f) \$ 7.330

Stockholders' Equity

Common stock, \$10 par: 90,000
shares issued and outstanding \$900,000

Retained earnings (g) 208,075

Total \$1,108,075

Total liabilities and stockholders' equity \$1,115,405

(a) Outstanding accounts = 5% of February sales (\$217,000) \$10,850

+ 90% of March sales (\$97,000) (see Example 12) 87,300

\$98,150

(b) Materials beginning inventory (Jan. 1 units from Example 3) 264

Add: Purchases for the quarter (units) 3,166

Materials available for use 3,430

Less: Production for the quarter (units from Example 2) 3,250

Total materials ending inventory (Mar. 31 units from Example 3) 180

Units cost	× \$25
Cost of materials inventory	<u>\$4,500</u>
(c) Finished goods inventory (Mar. 31 units from Example 2)	1,100
Standard cost per unit (Example 7)	× \$84
Cost of finished goods inventory	<u>\$92,400</u>
(d) Accumulated depreciation of equipment, Jan. 1	\$7,140
Add: Depreciation for the quarter ($\$1,350 \times 3 \text{ months} \times 60\%$)	<u>2,430</u>
Accumulated depreciation of equipment, Mar. 31	<u>\$9,570</u>
(e) Accumulated depreciation of buildings, Jan. 1	\$48,460
Add: Depreciation for the quarter ($\$1,350 \times 3 \text{ months} \times 40\%$)	<u>1,620</u>
Accumulated depreciation of buildings, Mar. 31	<u>\$50,080</u>
(f) 40% of March purchases (\$18,325 from Example 13)	<u>\$7,330</u>
(g) Retained earnings, Jan. 1	\$149,130
Add: Net income for the quarter (Example 11)	<u>58,945</u>
Retained earnings, Mar. 31	<u>\$208,075</u>

Solved Problems

7.1 Production Budget. The Tarver Manufacturing Company has estimated its sales budget at 500,000 units for the quarter ending March 31, 19X1. Anticipated sales for January, February, and March are 37.5%, 25%, and 37.5% of the total, respectively. The desired

	Units
January 1	90,000
January 31	87,500
February 28	93,000
finished goods inventories are as follows: March 31	95,000

Prepare a production budget for the first quarter of 19X1.

SOLUTION

Tarver Manufacturing Company
Production Budget
First Quarter, 19X1

	Units			
	January	February	March	Total
Sales budget	187,500	125,000	187,500	500,000
Add: Desired ending inventory	87,500	93,000	95,000	95,000
Subtotal	275,000	218,000	282,500	595,000
Less: Beginning inventory	90,000	87,500	93,000	90,000
Production units required	185,000	130,500	189,500	505,000

7.2 Direct Materials Purchase Budget. Jimmy Manufacturing Company has estimated its 19X0

April	1,500
May	2,000
June	2,500
July	2,800

production requirements to be as follows:

The company wants a direct materials ending inventory of 35% of the next month's production. The price per unit is \$20, and it takes one unit of direct materials to produce one of finished goods. Prepare a direct materials purchase budget for the second quarter of 19X0.

SOLUTION

Jimmy Manufacturing Company
Direct Materials Purchase Budget
Second Quarter, 19X0

	April	May	June	Total
Production units required	1,500	2,000	2,500	6,000
Add: Desired ending inventory	(35% × 2,000) <u>700</u>	(35% × 2,500) <u>875</u>	(35% × 2,800) <u>980</u>	<u>980</u>
Subtotal	2,200	2,875	3,480	6,980
Less: Beginning inventory	(35% × 1,500) <u>525</u>	(35% × 2,000) <u>700</u>	(35% × 2,500) <u>875</u>	<u>525</u>
Purchases required	1,675	2,175	2,605	6,455
Cost per unit	<u>× \$20</u>	<u>× \$20</u>	<u>× \$20</u>	<u>× \$20</u>
Purchases cost	<u><u>\$33,500</u></u>	<u><u>\$43,500</u></u>	<u><u>\$52,100</u></u>	<u><u>\$129,100</u></u>

7.3 Direct Materials Usage Budget. Using the data for the Jimmy Manufacturing Company in the preceding problem, prepare a direct materials usage budget.

SOLUTION

Jimmy Manufacturing Company
Direct Materials Usage Budget
Second Quarter, 19X0

	April	May	June	Total
Direct materials required (units)	1,500	2,000	2,500	6,000
Materials unit cost	<u>× \$20</u>	<u>× \$20</u>	<u>× \$20</u>	<u>× \$20</u>
Direct materials usage cost	<u><u>\$30,000</u></u>	<u><u>\$40,000</u></u>	<u><u>\$50,000</u></u>	<u><u>\$120,000</u></u>

7.4 Direct Labor Budget. The Carter Manufacturing Company estimates its production requirement

to be 30,000 units for October; 38,000 for November; and 41,000 for December. It takes 3 direct labor hours, at a rate of \$15 per hour, to complete one unit. Prepare a direct labor budget.

SOLUTION

***Carter Manufacturing Company
Direct Labor Budget
Third Quarter***

	Oct.	Nov.	Dec.	Total
Production units required	30,000	38,000	41,000	109,000
Direct labor hours (3 per unit)	90,000	114,000	123,000	327,000
Rate per hour	× \$15	× \$15	× \$15	× \$15
Direct labor cost	<u>\$1,350,000</u>	<u>\$1,710,000</u>	<u>\$1,845,000</u>	<u>\$4,905,000</u>

7.5 Factory Overhead Budget. The Rogers Manufacturing Company estimates its factory overhead to be as follows: *Fixed Expenses per Month*

Indirect materials	\$2,000
Indirect labor	900
Maintenance	200
Heat and light	500
Power	350
Insurance	540
Taxes	700
Depreciation	1,200

Variable Factory Overhead Rates per Direct Labor Hour

Indirect labor	\$0.25
Payroll taxes	0.10
Maintenance	0.30
Power	0.50
Heat and light	0.30

Assuming that the direct labor hours for January, February, and March are 2,500, 4,000, and 3,500 hours, respectively, prepare a factory overhead budget for the first quarter, 19X1.

SOLUTION

Rogers Manufacturing Company
Factory Overhead Budget

January 19X1
Direct Labor Hours: 2,500

Type of Expense	Fixed	Variable	Total
Indirect materials	\$2,000		\$ 2,000
Indirect labor	900	\$ 625	1,525
Maintenance	200	750	950
Heat and light	500	750	1,250
Power	350	1,250	1,600
Insurance	540		540
Taxes	700		700
Payroll taxes		250	250
Depreciation	<u>1,200</u>		<u>1,200</u>
Total	<u><u>\$6,390</u></u>	<u><u>\$3,625</u></u>	<u><u>\$10,015</u></u>

February, 19X1
Direct Labor Hours: 4,000

Indirect materials	\$2,000		\$ 2,000
Indirect labor	900	\$1,000	1,900
Maintenance	200	1,200	1,400
Heat and light	500	1,200	1,700
Power	350	2,000	2,350
Insurance	540		540
Taxes	700		700
Payroll taxes		400	400
Depreciation	<u>1,200</u>		<u>1,200</u>
Total	<u><u>\$6,390</u></u>	<u><u>\$5,800</u></u>	<u><u>\$12,190</u></u>

March, 19X1
Direct Labor Hours: 3,500

Indirect materials	\$2,000		\$ 2,000
Indirect labor	900	\$ 875	1,775
Maintenance	200	1,050	1,250
Heat and light	500	1,050	1,550
Power	350	1,750	2,100
Insurance	540		540
Taxes	700		700
Payroll taxes		350	350
Depreciation	<u>1,200</u>		<u>1,200</u>
Total	<u><u>\$6,390</u></u>	<u><u>\$5,075</u></u>	<u><u>\$11,465</u></u>

7.6 Cost of Goods Sold Budget. The Reagan Company has estimated the percentage of total manufacturing cost for each month in relation to the total for the second quarter to be as

April 30%

May 34%

follows: June 36%

The estimated costs for the second quarter are

Direct materials	\$100,000
Direct labor	120,000
Factory overhead	90,000

Estimated ending inventories of finished goods are as follows:

March 31	\$50,000
April 30	48,000
May 31	56,000
June 30	59,000

Prepare a quarterly cost of goods sold budget.

SOLUTION

Reagan Company
Cost of Goods Sold Budget
Second Quarter

	April	May	June	Total
Direct materials	\$ 30,000 (a)	\$ 34,000 (b)	\$ 36,000 (c)	\$100,000
Direct labor	36,000	40,800	43,200	120,000
Factory overhead	<u>27,000</u>	<u>30,600</u>	<u>32,400</u>	<u>90,000</u>
Total manufacturing cost	\$ 93,000	\$105,400	\$111,600	\$310,000
Add: Finished goods, beginning	<u>50,000</u>	<u>48,000</u>	<u>56,000</u>	<u>90,000</u>
Subtotal	\$143,000	\$153,400	\$167,600	\$360,000
Less: Finished goods, ending	<u>48,000</u>	<u>56,000</u>	<u>59,000</u>	<u>59,000</u>
Cost of goods sold	<u><u>\$ 95,000</u></u>	<u><u>\$ 97,400</u></u>	<u><u>\$108,600</u></u>	<u><u>\$301,000</u></u>

(a) $\$100,000 \times 30\%$. (b) $\$100,000 \times 34\%$. (c) $\$100,000 \times 36\%$.

7.7 Budgeted Income Statement. The T&M Wild Corporation anticipates sales of \$900,000 for the current year. The percentage of gross profit from sales has been 40% in past years. Operating expenses are expected to be \$200,000, of which 45% is administrative expenses and 55% is selling expenses. Assuming a 40% tax rate, prepare a budgeted income statement for the T&M Wild Corporation for 19X2.

SOLUTION

T&M Wild Corporation
Budgeted Income Statement
Year Ended, December, 19X2

Sales	\$900,000	100%
Cost of goods sold	<u>540,000</u>	<u>60%</u>
Gross profit	\$360,000	40%
<i>Operating expenses</i>		
Selling expenses (55%)	\$110,000	12%
Administrative expenses (45%)	<u>90,000</u>	<u>10%</u>
Total (100%)	<u>\$200,000</u>	<u>22%</u>
Net income before taxes	\$160,000	18%
Income tax (40%)	<u>64,000</u>	<u>7%</u>
Net Income	<u><u>\$96,000</u></u>	<u><u>11%</u></u>

7.8 Cash Budget. The Martha Corporation's budget department gathered the following data for the third quarter, 19X9:

Projected sales (units)	1,000	1,500	1,450
Selling price per unit	\$40	\$40	\$40
Direct materials purchase requirements (units)	1,300	2,000	1,800
Purchase cost per unit	\$20	\$20	\$20
Production requirement (units)	800	1,300	1,100

Direct labor hours	2 per complete unit	
Direct labor rate	\$12 per direct labor hour	
Fixed factory overhead	\$500 per month (including \$200 depreciation)	
Variable factory overhead	\$1.50 per direct labor hour	
Selling and administrative expenses	5% of sales	
Net income before taxes	July	\$ 6,000
	August	10,000
	September	8,000

All sales and purchases are for cash, and all expenses are paid in the month incurred. Assuming that the beginning cash balance on July 1, 19X9, is \$65,000 and the tax rate is 40%, prepare a cash budget for the third quarter, 19X9.

SOLUTION

Martha Corporation
Cash Budget
Third Quarter, 19X9

	July	Aug.	Sept.	Total
Cash balance, beginning	\$ 65,000	\$ 52,700	\$30,300	\$ 65,000
<i>Cash Receipts</i>				
Cash sales	<u>40,000 (a)</u>	<u>60,000</u>	<u>58,000</u>	<u>158,000</u>
Total cash available	<u>\$105,000</u>	<u>\$112,700</u>	<u>\$88,300</u>	<u>\$223,000</u>
<i>Cash Disbursements</i>				
Direct materials	\$ 26,000 (b)	\$ 40,000	\$36,000	\$102,000
Direct labor	19,200 (c)	31,200	26,400	76,800
Factory overhead	2,700 (d)	4,200	3,600	10,500

Selling and administrative expenses	2,000 (e)	3,000	2,900	7,900
Income taxes	<u>2,400 (f)</u>	<u>4,000</u>	<u>3,200</u>	<u>9,600</u>
Total	<u>\$ 52,300</u>	<u>\$ 82,400</u>	<u>\$72,100</u>	<u>\$206,800</u>
Ending balance	<u><u>\$ 52,700</u></u>	<u><u>\$ 30,300</u></u>	<u><u>\$16,200</u></u>	<u><u>\$ 16,200</u></u>

(a) $1,000 \text{ units} \times \$40 = \$40,000.$

(b) $1,300 \text{ units} \times \$20 = \$26,000.$

(c) $800 \text{ units} \times 2 \text{ hours per unit} = 1,600 \text{ hours} \times \$12 \text{ per hour} = \$19,200.$

(d) \$500 – \$200 depreciation	\$ 300	fixed (depreciation removed because it is not an outflow of cash.)
1,600 hours × \$1.50	<u>2,400</u>	variable
	<u><u>\$2,700</u></u>	

(e) $\$40,000 \times 5\% = \$2,000.$

(f) $\$6,000 \text{ net income before taxes} \times 40\% = \$2,400.$

Chapter 8

Standard Costs and Gross Profit Analysis

Standard Costs

8.1 STANDARD COSTS DEFINED

A carefully prepared predetermined or normal standard cost is expressed in terms of a single unit. It represents a product's planned cost and is generally established well before production begins, thus providing a goal to aim for. Standard cost is concerned with unit cost and serves basically the same purpose as a budget, but on a smaller scale, since the latter is concerned with total rather than unit costs.

8.2 TYPES OF STANDARDS

- (1) *Fixed or Basic Standards*. These are rarely used because once established, these standards are never changed.
- (2) *Ideal Standards*. Usually these standards cannot be attained and lead to unfavorable variances because they assume: (A) Minimum prices for all costs (direct materials, direct labor, and factory overhead) (B) Optimal usage of direct materials, direct labor, and factory overhead (C) 100% manufacturing capacity
- (3) *Attainable Standards*. These are standards that can be met even though based on a high degree of efficiency because they recognize: (A) Good overall prices can be obtained but not necessarily the lowest prices for all costs (direct materials, direct labor, and factory overhead).
 - (B) Direct labor is not 100% efficient.
 - (C) Normal spoilage will occur.
 - (D) Manufacturers do not operate at 100% capacity.

8.3 ESTABLISHMENT OF STANDARDS

(1) *Direct Materials Standards*

- (A) *Direct Materials Price (Rate) Standard*. This standard, which is the unit price for direct materials, must be set for each type of direct material used in production. The determination of this standard includes knowledge of expected production as well as the price/quality relationship of various suppliers.

Since prices are subject to change, a weighted average standard price per unit must be used or, preferably, the standard price per unit should be adjusted as needed.
- (B) *Direct Materials Efficiency (Usage) Standard*. This standard is determined as the

quantity of direct materials that should be used in each unit produced. Each direct material requires its own standard. This standard is usually based on prior experience and/or engineering studies.

(2) ***Direct Labor Standards***

(A) *Direct Labor Price Standard*. This standard is based upon the predetermined direct labor rates for the period. Changes in labor rates are handled in the same way as changes in direct material rates.

(B) *Direct Labor Efficiency Standard*. This standard is the number of direct labor hours needed to complete one unit. Time and motion studies, taking into consideration the experience of workers, are often used to set this standard.

(3) ***Factory Overhead Standards*** Before this standard can be determined, factory overhead costs must be separated into their fixed and variable components. Separate fixed and variable factory overhead standards are then established based upon past costs and expected economic conditions.

The factory overhead standard is normally expressed in terms of the allocation base used, such as direct labor hours or cost or machine hours.

8.4 ESTABLISHING STANDARDS IN PROCESS AND JOB ORDER COST SYSTEMS

Standards for direct materials, direct labor, and factory overhead are determined by department in a process cost system and by job in a job order cost system.

EXAMPLE 1

Next year the Broadway Company expects to manufacture 2,000 pairs of theater curtains which will sell for \$400 per pair. The total amount of direct materials required is 48,000 yards of fabric which can be purchased from a wholesaler for \$2 per yard.

Two workers are involved in production—one to cut the fabric and the other to sew the curtains. It takes one hour to cut each pair of curtains, and that worker is paid \$10 per hour. It then takes one hour to sew the curtains, and that worker is paid \$8 per hour.

The factory overhead to produce 2,000 pairs of curtains is budgeted at \$6,000 for variable costs and \$8,000 for fixed costs.

All processing is accomplished in one department. The factory closes for two weeks at Christmas.

Direct materials price standard	\$2/yard
Direct materials efficiency standard	24 yards/pair
Direct labor price standard (\$36,000/4,000)*	\$9/direct labor hour

* Computation of total annual direct labor hours and cost:

	Direct Labor Hours/ Week	x	Weeks/ Year	=	Total Annual Direct Labor Hours	x	Hourly Rate/ Direct Labor Hour	=	Total Annual Direct Labor Cost
Worker 1	40		50		2,000		\$10.00		\$20,000
Worker 2	40		50		<u>2,000</u>		8.00		<u>16,000</u>
					<u><u>4,000</u></u>				<u><u>\$36,000</u></u>

Direct labor efficiency standard:

Worker 1: 1 hour; Worker 2: 1 hour = 2 direct labor hours/pair of curtains
Variable factory overhead application rate:

$$\frac{\$6,000}{4,000 \text{ direct labor hours}} = \$1.50/\text{direct labor hour}$$

Fixed factory overhead application rate:

$$\frac{\$8,000}{4,000 \text{ direct labor hours}} = \$2.00/\text{direct labor hour}$$

Total factory overhead application rate:

$$\frac{\$14,000}{4,000 \text{ direct labor hours}} = \$3.50/\text{direct labor hour}$$

8.5 QUALITY CONTROL

When standard costs are established, the company must consider its policy regarding quality control. If products are defective, rework costs and potential liability claims will increase the costs of the company.

A company should consider such quality items as quality specification (design quality); workmanship (production quality); and product reliability (expectation of satisfactory operation for a specific time under normal usage conditions).

An important element of quality control known as a *zero defect program* is aimed at eliminating defects and therefore improving quality in the product line. It assumes that defects are caused by lack of knowledge, lack of proper facilities, and lack of attention.

A zero defect program conditions employees to realize that defects need not happen. It challenges the individual to establish goals for superior performance and to strive for personal excellence. As an employee achieves this, defects are reduced, and the quality of the product improves. Such a program also provides recognition of individual achievement.

8.6 JUST-IN-TIME PHILOSOPHY

The greater use of automated equipment in the production process has substantially reduced the direct labor content of products while increasing fixed factory overhead costs. The effect is twofold. First, direct labor used to apply factory overhead costs is probably no longer an appropriate base. Second, as increased factory overhead costs are spread over products, inventories build up for finished goods not sold.

An alternative is to reduce costs using a just-in-time (JIT) philosophy. JIT analyzes manufacturing time as: (1) **Processing Time**. Actual time a product is worked on.

(2) **Inspection Time**. Inspection of raw materials and of the product at different manufacturing stages to determine if it conforms to standards. Also includes any necessary rework costs.

(3) **Moving Time**. The time it takes to move a product from one department to the next.

(4) **Queue or Waiting Time**. The time the product remains in a production department before it is worked on.

(5) **Storage Time**. The time raw materials, work-in-process, and finished products remain in storage before they are used by a production department or sold.

The sum of these five times is called *throughput time*. It can be seen that only one of these times is actually processing time, i.e., time worked on the product. This processing time is sometimes called *value-added time*. The remaining four times are called *nonvalue-added time* or *waste time*. This can be summarized in the following equation:

$$\text{Throughput time} = \begin{array}{c} \text{Value-added time} \\ \text{or} \\ \text{Processing time} \end{array} + \begin{array}{c} \text{Nonvalue-added time} \\ \text{or} \\ \text{Waste time} \end{array}$$

The philosophy of JIT is to identify the *causes* of waste time and implement strategies that will minimize throughput time. Some strategies include: (1) *Reduce inspection time* by improving quality.

(2) *Reduce moving time* by better plant design.

(3) *Reduce queue (waiting) time* by better coordination among production departments. Better

quality will move a product more smoothly and more efficiently. Better design of products and equipment will reduce *set-up time*. Set-up time is the time it takes to reorganize the equipment to produce different product.

- (4) *Reduce storage time* by working with suppliers for better delivery and better conformance to specifications to eliminate purchases of excess inventory. Better coordination among departments will reduce the need to store more finished goods.

The elimination of waste time in inspecting and storing raw materials is called *JIT purchasing*. The elimination of waste time in manufacturing the product is called *JIT manufacturing*. Elimination of waste time, that is, to have materials and finished products available *just in time*, will reduce costs.

8.7 VARIANCE ANALYSIS

The use of a standard cost system aids management in controlling costs. Once actual costs are incurred, the differences between the expected and the actual, called variances, are computed and analyzed.

Variances are used to evaluate performance and correct inefficiencies. Following is a list of the variances used in a standard cost system: (1) ***Direct materials variances***

- (A) *Direct materials price variance*

$$\text{Direct materials price variance} = \left(\begin{array}{c} \text{Actual} \\ \text{unit} \\ \text{price} \end{array} - \begin{array}{c} \text{Standard} \\ \text{unit} \\ \text{price} \end{array} \right) \times \begin{array}{c} \text{Actual} \\ \text{quantity} \\ \text{purchased} \end{array}$$

- (B) *Direct materials efficiency (quantity or usage) variance*

$$\text{Direct materials efficiency variance} = \left(\begin{array}{c} \text{Actual} \\ \text{quantity} \\ \text{used} \end{array} - \begin{array}{c} \text{Standard} \\ \text{quantity} \\ \text{allowed (a)} \end{array} \right) \times \begin{array}{c} \text{Standard} \\ \text{unit} \\ \text{price} \end{array}$$

$$\text{(a) Standard quantity allowed} = \begin{array}{c} \text{Standard} \\ \text{quantity} \\ \text{per unit} \end{array} \times \begin{array}{c} \text{Standard} \\ \text{quantity} \\ \text{per unit} \end{array} \times \begin{array}{c} \text{Equivalent} \\ \text{production} \end{array}$$

- (2) ***Direct labor variances***

- (A) *Direct labor price (rate) variance*

$$\text{Direct labor price variance} = \left(\begin{array}{c} \text{Actual hourly} \\ \text{wage rate} \end{array} - \begin{array}{c} \text{Standard hourly} \\ \text{wage rate} \end{array} \right) \times \begin{array}{c} \text{Actual number of direct} \\ \text{labor hours worked} \end{array}$$

- (B) *Direct labor efficiency variance*

$$\text{Direct labor efficiency variance} = \left(\begin{array}{c} \text{Actual direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard direct} \\ \text{labor hours} \\ \text{allowed (b)} \end{array} \right) \times \begin{array}{c} \text{Standard direct} \\ \text{labor hourly} \\ \text{wage rate} \end{array}$$

$$(b) \text{ Standard direct labor hours allowed} = \text{Standard number of direct labor hours per unit} \times \text{Equivalent production}$$

(3) *Factory Overhead Variances*

(A) *One-factor analysis of factory overhead variance*

$$\text{Overall factory overhead variance} = \text{Actual factory overhead} - \text{Applied factory overhead (c)}$$

$$(c) \text{ Applied factory overhead} = \text{Standard direct labor hours allowed (b)} \times \text{Standard factory overhead application rate}$$

(B) *Two-factor analysis of factory overhead variances.* With this method, the factory overhead variance has two components: budget (controllable) variance and production volume (denominator or idle capacity) variance. The sum of these two components equals the one-factor variance.

(1) *Budget (controllable) variance*

$$\text{Budget (controllable) variance} = \text{Actual factory overhead} - \text{Budgeted factory overhead at standard direct labor hours allowed (d)}$$

$$(d) \text{ Budgeted factory overhead at standard direct labor hours allowed} = \text{Variable factory overhead (standard direct labor hours allowed} \times \text{standard variable factory overhead application rate)} + \text{Fixed (budgeted) factory overhead}$$

(2) *Production volume (denominator or idle capacity) variance*

$$\text{Production volume (denominator or idle capacity) variance} = \left(\text{Denominator direct labor hours (e)} - \text{Standard direct labor hours allowed (f)} \right) \times \text{Standard fixed factory overhead application rate}$$

(e) The denominator direct labor hours are the original expected or normal capacity hours used to determine the factory overhead application rate.

(f) Standard direct labor hours allowed. See (b) above.

(C) *Three-factor analysis of factory overhead variances.* With this method, the factory

overhead variance has three components: price (spending) variance, efficiency variance, and production volume variance.

The sum of the price (spending) variance and the efficiency variance equals the budget variance in the two-factor analysis. The production volume variance is computed the same way as in the two-factor analysis.

The sum of the three components equals the same total variance as resulted from the one-and two-factor analyses of factory overhead variances.

(1) *Price (spending) variance*

$$\text{Price (spending) variance} = \text{Actual factory overhead} - \text{Budgeted factory overhead at actual direct labor hours worked (f)}$$

(f)

$$\text{Budgeted factory overhead at actual direct labor hours worked} = \text{Variable factory overhead (actual direct labor hrs. worked} \times \text{standard variable factory overhead application rate} + \text{Fixed (budgeted) factory overhead}$$

(2) *Efficiency variance*

$$\text{Efficiency variance} = \left(\text{Actual direct labor hours worked} - \text{Standard direct labor hours allowed} \right) \times \text{Standard variable factory overhead application rate}$$

This variance will indicate if the workers were efficient (favorable variance) or inefficient (unfavorable variance).

(3) *Production volume variance*. Same as for two-factor analysis method.

EXAMPLE 2

Continuing with the illustration of the Broadway Company, summarized below are the standard and actual amounts:

	Standard	Actual
Direct materials purchased	48,000 yds (@ \$2/yd)	50,000 yds (@ \$2.25)
Direct materials used		44,000 yds
Direct materials efficiency standard	24 yds/pair	
Direct labor price standard	\$9/dlh	
Direct labor efficiency standard	2 dlh/pair	
Direct labor costs	\$36,000	\$40,000
Direct labor hours	4,000	3,900

	Standard	Actual
Factory overhead:		
Variable	\$6,000 or \$1.50/dlh*	\$6,200
Fixed	\$8,000 or \$2/dlh	\$7,500
Total	\$14,000 or \$3.50/dlh	\$13,700
Production:		
Units started and completed	2,000	1,800
Work-in-process inventory— ending (100% direct materials, 50% conversion costs)	-0-	200

* dlh = direct labor hours

8.8 COMPUTATION OF VARIANCES

(1) Direct Materials Price Variance

$$\begin{aligned}
 \text{Direct materials price variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{unit} \\ \text{price} \end{array} - \begin{array}{c} \text{Standard} \\ \text{unit} \\ \text{price} \end{array} \right) \times \begin{array}{c} \text{Actual} \\ \text{quantity} \\ \text{purchased} \end{array} \\
 &= (\$2.25 - \$2.00) \times 50,000 \text{ yds} \\
 \$12,500 \text{ Unfav.} &= \$0.25 \times 50,000 \text{ yds}
 \end{aligned}$$

(2) Direct Materials Efficiency Variance

$$\begin{aligned}
 \text{Direct materials efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{quantity} \\ \text{used} \end{array} - \begin{array}{c} \text{Standard} \\ \text{quantity} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard} \\ \text{unit} \\ \text{price} \end{array} \\
 &= [44,000 - 48,000 \text{ (a)}] \times \$2.00 \\
 (\$8,000) \text{ Fav.} &= -4,000 \times \$2.00
 \end{aligned}$$

(a) $\text{Standard quantity allowed} = \text{Standard quantity per unit} \times \text{Equivalent production}$

$$48,000 = 24 \times \left(\begin{array}{l} 1,800 \text{ units started and completed} \\ + 200 \text{ work-in-process inventory,} \\ \text{ending} \times 100\% \text{ direct materials} \end{array} \right)$$

(3) Direct Labor Price Variance

$$\begin{aligned}
 \text{Direct labor price variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{hourly} \\ \text{wage rate} \end{array} - \begin{array}{c} \text{Standard} \\ \text{hourly} \\ \text{wage rate} \end{array} \right) \times \begin{array}{c} \text{Actual number} \\ \text{of direct labor} \\ \text{hours worked} \end{array} \\
 &= [(\$40,000/3,900 \text{ dlh}) - (\$36,000/4,000 \text{ dlh})] \times 3,900 \text{ dlh} \\
 &= (\$10.26 - \$9.00) \times 3,900 \text{ dlh} \\
 \$4,914 \text{ Unfav.} &= \$1.26 \times 3,900 \text{ dlh}
 \end{aligned}$$

(4) Direct Labor Efficiency Variance

$$\begin{aligned}
 \text{Direct labor efficiency variance} &= \left(\begin{array}{c} \text{Actual direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard direct} \\ \text{labor hours} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard direct} \\ \text{labor hourly} \\ \text{wage rate} \end{array} \\
 &= [3,900 - 3,800 \text{ (b)}] \times \$9.00/\text{dlh} \\
 \$900 \text{ Unfav.} &= 100 \times \$9.00/\text{dlh}
 \end{aligned}$$

$$\begin{aligned}
 \text{(b) Standard direct labor hours allowed} &= \text{Standard number of direct labor hours per unit} \times \text{Equivalent production} \\
 3,800 &= 2 \text{ dlh/pair} \times \left(\begin{array}{l} 1,800 \text{ units started \& completed} \\ + 100 \text{ work-in-process inventory,} \\ 50\% \text{ conversion costs} \\ (200 \text{ pair} \times .50) \end{array} \right)
 \end{aligned}$$

(5) Factory Overhead Variance

(A) One-factor analysis

$$\begin{aligned}
 \text{Overall factory overhead variance} &= \text{Actual factory overhead} - \text{Applied factory overhead} \\
 \$400 \text{ Unfav.} &= \$13,700 - \$13,300 \text{ (c)}
 \end{aligned}$$

$$\begin{aligned}
 \text{(c) Applied factory overhead} &= \text{Standard direct labor hours allowed} \times \text{Standard factory overhead application rate} \\
 \$13,300 &= 3,800 \times \$3.50
 \end{aligned}$$

(B) Two-factor analysis

(1) Budget (controllable) variance

$$\begin{aligned}
 \text{Budget (controllable) variance} &= \text{Actual factory overhead} - \text{Budgeted factory overhead at standard direct labor hours allowed} \\
 \$-0- &= \$13,700 - \$13,700 \text{ (d)}
 \end{aligned}$$

$$\begin{aligned}
 \text{(d) Budgeted factory overhead at standard direct labor hours allowed} &= \text{Variable factory overhead (standard direct labor hours allowed} \times \text{standard variable factory overhead application rate)} + \text{Fixed (budgeted) factory overhead} \\
 &= [3,800 \text{ (see (b) above)} \times \$1.50] + \$8,000 \\
 \$13,700 &= \$5,700 + \$8,000
 \end{aligned}$$

(2) Production volume (denominator or idle capacity) variance

$$\begin{aligned}
 \text{Production volume (denominator or idle capacity) variance} &= \left(\text{Denominator direct labor hours} - \text{Standard direct labor hours allowed} \right) \times \text{Standard fixed factory overhead application rate} \\
 &= [4,000 \text{ dlh (e)} - 3,800 \text{ dlh}] \times \$2.00 \\
 \$400 \text{ Unfav.} &= 200 \text{ dlh} \times 2.00
 \end{aligned}$$

(e) The 4,000 dlh denominator is the original standard direct labor hours.

Budget variance	+	Production volume variance	=	Overall factory overhead variance (as in the one-factor analysis method)
-0-	+	\$400 Unfav.	=	\$400 Unfav.

(C) *Three-factor analysis*

(1) *Price (spending) variance*

Price (spending) variance (\$150) Fav.	=	Actual factory overhead = \$13,700	-	Budgeted factory overhead at actual direct labor hours worked = \$13,850 (f)
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(f) Budgeted factory overhead at actual direct labor hours worked	=	Variable factory overhead (actual direct labor hours worked × standard variable factory overhead application rate)	+	Fixed (budgeted) factory overhead
	=	(3,900 × \$1.50)	+	\$8,000
\$13,850	=	5,850	+	\$8,000

(2) *Efficiency variance*

$$\begin{aligned} \text{Efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct} \\ \text{labor hours} \\ \text{allowed} \end{array} \right) \times \text{Standard variable} \\ &= (3,900 \text{ dlh} - 3,800 \text{ dlh}) \times \$1.50 \\ &= 100 \text{ dlh} \times \$1.50 \\ &(\$150) \\ &\text{Unfav.} \end{aligned}$$

Price variance	+	Efficiency variance	=	Budget variance (as in the two-factor analysis method)
(\$150) Fav.	+	\$150 Unfav.	=	\$-0-

(3) *Production volume variance*: Same as calculated in the two-factor analysis method.

Price variance	+	Efficiency variance	+	Production variance	=	Overall factory overhead variance (as in the one- factor analysis method)
(\$150) Fav.	+	\$150 Unfav.	+	\$400 Unfav.	=	\$400 Unfav.

8.9 JOURNAL ENTRIES IN A STANDARD COST SYSTEM

Standard costs are recorded as journal entries in addition to actual costs recorded for either job order or process cost systems.

In a standard cost system, work-in-process inventory, finished goods inventory, and cost of goods sold are maintained at standard cost. Separate variance accounts are established to record differences from the standard costs. Unfavorable variances are debit entries, and favorable variances are credit entries.

EXAMPLE 3

Continuing the example of the Broadway Company, the journal entries will be illustrated. The standard, actual, and variance data are summarized below:

	Standard	Actual	Variance
Direct materials purchased	48,000 yds (@ \$2/yd)	50,000 yds (@ \$2.25)	
Direct materials used		44,000 yds	
Direct materials efficiency standard	24 yds/ pair		
Direct labor price standard	\$9/dlh		
Direct labor efficiency standard	2 dlh/pair		
Direct labor costs	\$36,000	\$40,000	
Direct labor hours	4,000	3,900	
Factory overhead:			
Variable	\$6,000 or \$1.50/dlh	\$6,200	
Fixed	\$8,000 or \$2/dlh	\$7,500	
Total	\$14,000 or \$3.50/dlh	13,700	

	Standard	Actual	Variance
Production:			
Units started and completed	2,000	1,800	
Work-in-process inventory—ending (100% direct materials, 50% conversion costs)	-0-	200	
Units sold		1,600	
Variances:			
Direct materials price			\$12,500 Unfav.
Direct materials efficiency			(\$ 8,000) Fav.
Direct labor price			\$ 4,914 Unfav.
Direct labor efficiency			\$ 900 Unfav.
Factory overhead:			
One-factor analysis			\$ 400 Unfav.
Two-factor analysis:			
Budget			-0-
Production volume			\$ 400 Unfav.
Three-factor analysis:			
Price			(\$ 150) Fav.
Efficiency			\$ 150 Unfav.
Production volume			\$ 400 Unfav.

**Direct
Materials****Conversion
Costs**

Equivalent production:

Started and completed	1,800	1,800
Work-in-process inventory	<u>200 (100%)</u>	<u>100 (50%)</u>
Total	<u><u>2,000</u></u>	<u><u>1,900</u></u>

To record the purchase of direct materials:

Materials inventory (50,000 yds × \$2.00)	100,000	
Direct Materials price variance	12,500*	
Accounts payable (50,000 yds. × \$2.25)		112,500

* ($\$2.25 - \$2.00 = \$0.25 \times 50,000$ yds)

To record the use of direct materials:

Work-in-process inventory (2,000 equivalent production × 24 yds = 48,000 yds × \$2)	96,000	
Direct materials efficiency variance (44,000 yds - 48,000 yds = 4,000 × \$2)		8,000
Materials Inventory (44,000 yds × \$2.00)		88,000

To record direct labor costs:

Work-in-Process Inventory (1,900 equivalent production \times 2 dlh/pair = 3,800 \times \$9.00)	34,200	
Direct Labor Price Variance ($\$10.26 - \$9.00 = \$1.26 \times 3,900$)	4,914	
Direct Labor Efficiency Variance ($3,900 - 3,800 = 100 \times \9.00)	900	
Payroll Payable (3,900 dlh \times \$10.26)		40,014

To record actual factory overhead costs:

Factory Overhead Control	13,700	
Various Credits ($\$6,200 + \$7,500$)		13,700

To record applied factory overhead costs:

Work-in-Process Inventory (3,800 dlh \times \$3.50/dlh)	13,300	
Factory Overhead Applied		13,300

To record factory overhead variances:

One-variance method:

Factory Overhead Applied	13,300	
Total Factory Overhead Variance	400	
Factory Overhead Control		13,700

Two-variance method:

Factory Overhead Applied	13,300	
Factory Overhead Budget Variance	0	
Factory Overhead Production Volume Variance	400	
Factory Overhead Control		13,700

Three-variance method:

Factory Overhead Applied	13,300	
Factory Overhead Efficiency Variance	150	
Factory Overhead Production Volume Variance	400	
Factory Overhead Price Variance		150
Factory Overhead Control		13,700

8.10 DISPOSITION OF ALL VARIANCES

Variations will either be charged off as a period cost (if inventories are reported on financial statements at standard costs) or prorated among work-in-process inventory, finished goods inventory, and cost of goods sold (if inventories are reported on financial statements at actual costs). If the variations are prorated, then they are considered product costs.

Proration of Variations. If the variations are large (the actual costs depart significantly from standard costs), the variations should be prorated to the inventory accounts (if any) and cost of goods sold.

The proration is based on a ratio (fraction) of the quantities or dollar amounts of each account to the total quantity or dollar amounts of all accounts.

Direct materials and conversion costs are allocated separately when they are at different stages of completion.

Gross Profit Analysis

8.11 GROSS PROFIT ANALYSIS DEFINED

Another area of cost accounting that utilizes variances is known as gross profit analysis. Deviations from the amount of gross profit that is expected must be evaluated carefully.

Gross profit or gross margin is the excess of sales over cost of goods sold. Gross profit analysis is the determination of the causes for the increase or decrease in gross profit. Any variances that affect gross profit are reported to management so that corrective steps can be taken.

8.12 CHANGE IN GROSS PROFIT

The principal causes of a difference between budgeted and actual gross profit are changes in sales price, sales volume, cost of goods sold, and product mix. Analysis of the changes provides the data needed to bring actual operations in line with budgeted expectations. Comparisons can be made between budgeted and actual operations for the current year or between actual operations for the prior year and those for the current year. It is preferable to compare actual with budget when a realistic budget has been prepared.

In addition to computing the gross profit ratio (gross profit \div sales), the changes in gross profit can also be analyzed by the following three variances: (1) *Volume Variance*. Due to a change in quantity. It is computed as follows:

$$\text{Volume variance} = \left(\frac{\text{Budgeted volume} - \text{Actual volume}}{\text{Budgeted volume}} \right) \times \text{Budgeted gross profit per unit}$$

(2) *Sales Price Variance*. Due to change in selling price.

$$\text{Sales price variance} = \left(\frac{\text{Budgeted unit sales price} - \text{Actual unit sales price}}{\text{Budgeted unit sales price}} \right) \times \text{Actual volume}$$

(3) *Cost Variance*. Due to change in costs.

$$\text{Cost variance} = \left(\frac{\text{Budgeted cost per unit} - \text{Actual cost per unit}}{\text{Budgeted cost per unit}} \right) \times \text{Actual volume}$$

EXAMPLE 4

The following is an illustration of a company's budgeted and actual gross profit for a single product:

	Budget	Actual	Change	Percent
Sales	\$50,000	\$53,000	\$ + 3,000	6.0%
Cost of goods sold	<u>25,000</u>	<u>27,500</u>	<u>-2,500</u>	<u>10.0%</u>
Gross profit	<u>\$25,000</u>	<u>\$25,500</u>	<u>\$ 500</u>	<u>2.0%</u>
Gross profit ratio (GPR = gross profit ÷ sales)	50.0%	48.1%		
Cost-of-goods-sold ratio (CSR = cost of goods sold ÷ sales)	<u>50.0%</u>	<u>51.9%</u>		
Total	<u>100.0%</u>	<u>100.0%</u>		

Cost Data per Unit

	Budget		Actual		Change
	(5,000 Units)		(4,000 Units)		(- 1,000 Units)
Sales price	\$ 10.00	100%	\$ 13.25	100%	\$+ 3.25
Cost of sales	<u>5.00</u>	<u>50%</u>	<u>6.875</u>	<u>51.9%</u>	<u>+ 1.875</u>
Gross profit	<u><u>\$ 5.00</u></u>	50%	<u><u>\$ 6.375</u></u>	48.1%	<u><u>\$+ 1.375</u></u>

$$\begin{aligned}
 \text{Volume variance} &= \left(\begin{array}{c} \text{Budgeted} \\ \text{volume} \end{array} - \begin{array}{c} \text{Actual} \\ \text{volume} \end{array} \right) \times \text{Budgeted gross profit per unit} \\
 &= (5,000 - 4,000) \times \$5 \\
 &= 1,000 \times \$5 \\
 &= \$5,000 \text{ Unfav.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Sales price variance} &= \left(\begin{array}{c} \text{Budgeted sales} \\ \text{price per unit} \end{array} - \begin{array}{c} \text{Actual sales} \\ \text{price per unit} \end{array} \right) \times \text{Actual volume} \\
 &= (\$10.00 - \$13.25) \times 4,000 \\
 &= -\$3.25 \times 4,000 \\
 &= \$13,000 \text{ Fav.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Cost variance} &= \left(\begin{array}{c} \text{Budgeted cost} \\ \text{per unit} \end{array} - \begin{array}{c} \text{Actual cost} \\ \text{per unit} \end{array} \right) \times \text{Actual volume} \\
 &= (\$5.00 - \$6.875) \times 4,000 \\
 &= -\$1.875 \times 4,000 \\
 &= \$7,500 \text{ Unfav.}
 \end{aligned}$$

The gross profit variance is summarized as follows:

Volume variance	\$ 5,000	Unfavorable
Sales price variance	(13,000)	Favorable
Cost variance	<u>7,500</u>	Unfavorable
Total	<u><u>(\$ 500)</u></u>	Favorable

8.13 MULTIPRODUCTS

Most manufacturing companies produce more than one product. Sales, cost of goods sold, and gross profit are usually different for each product. Analysis of cost data is handled in the same way as standard cost variance computations if the products cannot be substituted for each other. If substitutions can be made, the sales price and cost variances are computed as shown above, but the volume variance is separated into a pure volume and a mix variance.

(1) **Pure Volume Variance.** Indicates the effect of changes in the physical volume of the product sold. The formula is:

$$\text{Pure volume variance} = \left(\frac{\text{Budgeted volume} - \text{Actual volume}}{\text{Budgeted volume}} \right) \times \text{Budgeted average gross profit}^*$$

$$\text{* Budgeted average gross profit} = \frac{\text{Total budgeted gross profit}}{\text{Total budgeted units}}$$

(2) **Mix Variance.** Indicates the effect of changes in the physical volume of the more profitable or less profitable product. The determination of more profitable or less profitable is made by comparing the gross profit per unit with the average gross profit per unit for all units. A mix variance is unfavorable if a company sold more units of the less profitable product or sold fewer units of the more profitable product. The formula is:

$$\text{Mix variance} = \left(\frac{\text{Budgeted volume} - \text{Actual volume}}{\text{Budgeted volume}} \right) \times (\text{Budgeted average gross profit} - \text{Budgeted gross profit})$$

EXAMPLE 5

Consider the following gross profit analysis for a multiproduct company: *J. C. Manufacturing Co.*

Budgeted Gross Profit Statement
Year 19XX

Product	Units Sold	Sales		Cost		Gross Profit		
		Price	Amount	Unit	Amount	Unit	Amount	Percent
A	50,000	\$6.25	\$312,500	\$5.10	\$255,000	\$1.15	\$ 57,500	18.4 %
B	38,000	5.50	209,000	4.20	159,600	1.30	49,400	23.64%
C	18,000	4.00	72,000	3.00	54,000	1.00	18,000	25.00%
Total	106,000	\$5.60 (a)	\$593,500	\$4.42 (b)	\$468,600	\$1.18 (c)	\$124,900	21.04% (d)

(a) $\$593,500 \div 106,000$.

(b) $\$468,600 \div 106,000$.

(c) $\$124,900 \div 106,000$.

(d) $\$124,900 \div \$593,500$.

J. C. Manufacturing Co.
Actual Gross Profit Statement
Year 19XX

Product	Units Sold	Sales		Cost		Gross Profit		
		Price	Amount	Unit	Amount	Unit	Amount	Percent
A	53,000	\$6.50	\$344,500	\$5.78	\$306,340	\$0.72	\$ 38,160	11.08%
B	35,300	\$5.20	183,560	4.30	151,790	0.90	31,770	17.31%
C	<u>18,200</u>	<u>\$4.15</u>	<u>75,530</u>	<u>3.60</u>	<u>65,520</u>	<u>0.55</u>	<u>10,010</u>	<u>13.25%</u>
Total	<u><u>106,500</u></u>	<u><u>\$5.67 (a)</u></u>	<u><u>\$603,590</u></u>	<u><u>\$4.92 (b)</u></u>	<u><u>\$523,650</u></u>	<u><u>\$0.75 (c)</u></u>	<u><u>\$ 79,940</u></u>	<u><u>13.24% (d)</u></u>

(a) $\$603,590 \div 106,500$.

(b) $\$523,650 \div 106,500$.

(c) $\$79,940 \div 106,500$.

(d) $\$79,940 \div \$603,590$.

Budgeted gross profit	\$124,900	
Actual gross profit	<u>79,940</u>	
Variance—to be analyzed	<u><u>\$ 44,960</u></u>	Unfav.

(1) **No Substitutes**

$$\text{Volume variance} = \left(\text{Budgeted volume} - \text{Actual volume} \right) \times \text{Budgeted gross profit}$$

Product A

Product B

Product C

$$(50,000 - 53,000)$$

$$(38,000 - 35,300)$$

$$(18,000 - 18,200)$$

$$\times 1.15$$

$$\times \$1.30$$

$$\times \$1.00$$

$$-3,000 \times \$1.15$$

$$2,700 \times \$1.30$$

$$-200 \times \$1.00$$

$$(\$3,450) \text{ Fav.}$$

$$\$3,510 \text{ Unfav.}$$

$$(\$200) \text{ Fav.}$$

$$\text{Sales price variance} = \left(\text{Budgeted sales price per unit} - \text{Actual sales price per unit} \right) \times \text{Actual volume}$$

Product A	Product B	Product C
(\$6.25 – \$6.50)	(\$5.50 – \$5.20)	(\$4.00 – \$4.15)
× 53,000	× 35,300	× 18,200
–\$0.25 × 53,000	\$0.30 × 35,300	–\$0.15 × 18,200
(\$13,250) Fav.	\$10,590 Unfav.	(\$2,730) Fav.

$$\text{Cost variance} = \left(\begin{array}{c} \text{Budgeted cost} \\ \text{per unit} \end{array} - \begin{array}{c} \text{Actual cost} \\ \text{per unit} \end{array} \right) \times \text{Actual volume}$$

Product A	Product B	Product C
(\$5.10 – \$5.78)	(\$4.20 – \$4.30)	(\$3.00 – \$3.60)
× 53,000	× 35,300	× 18,200
–\$0.68 × 53,000	–\$0.10 × 35,300	–\$0.60 × 18,200
\$36,040 Unfav.	\$3,530 Unfav.	\$10,920 Unfav.

Summary of Variances
Multiproducts—No Substitutes

	<u>Product A</u>	<u>Product B</u>	<u>Product C</u>	<u>Total</u>
Volume variance	\$ (3,450) Fav.	\$ 3,510 Unfav.	\$ (200) Fav.	\$ (140) Fav.
Sales price variance	(13,250) Fav.	10,590 Unfav.	(2,730) Fav.	(5,390) Fav.
Cost variance	<u>36,040</u> Unfav.	<u>3,530</u> Unfav.	<u>10,920</u> Unfav.	<u>50,490</u> Unfav.
Total	<u><u>\$ 19,340</u></u> Unfav.	<u><u>\$17,630</u></u> Unfav.	<u><u>\$ 7,990</u></u> Unfav.	<u><u>\$ 44,960</u></u> Unfav.

(2) Substitutes

$$\text{Pure volume variance} = \left(\text{Budgeted volume} - \text{Actual volume} \right) \times \text{Budgeted average gross profit}^*$$

<u>Product A</u>	<u>Product B</u>	<u>Product C</u>
(50,000 – 53,000)	(38,000 – 35,300)	(18,000 – 18,200)
× \$1.18	× \$1.18	× \$1.18
– 3,000 × \$1.18	2,700 × \$1.18	– 200 \$ × \$1.18
(\$3,540) Fav.	\$3,186 Unfav.	(\$236) Fav.

$$* \$124,900 \div 106,000 = \$1.18$$

$$\text{Mix variance} = \left(\text{Budgeted volume} - \text{Actual volume} \right) \times \left(\text{Budgeted average gross profit}^* - \text{Budgeted gross profit} \right)$$

Product A	Product B	Product C
(50,000 – 53,000)	(38,000 – 35,300)	(18,000 – 18,200)
× (\$1.18 – \$1.15)	× (\$1.18 – \$1.30)	× (\$1.18 – \$1.00)
–3,000 × \$0.03	2,700 × –\$.12	–200 × \$0.18
\$90 Unfav.	\$324 Unfav.	\$36 Unfav.

$$* \$124,900 \div 106,000 = \$1.18$$

Sales price variance. Same as calculated for no substitutes.

Cost variance. Same as calculated for no substitutes.

Summary of Variances Multiproducts—Substitutes

	<u>Product A</u>	<u>Product B</u>	<u>Product C</u>	<u>Total</u>
Pure volume variance	\$ (3,540) Fav.	\$ 3,186 Unfav.	\$ (236) Fav.	\$ (590) Fav.
Mix variance	90 Unfav.	324 Unfav.	36 Unfav.	450 Unfav.
Sales price variance	(13,250) Fav.	10,590 Unfav.	(2,730) Fav.	(5,390) Fav.
Cost variance	<u>36,040</u> Unfav.	<u>3,530</u> Unfav.	<u>10,920</u> Unfav.	<u>50,490</u> Unfav.
Total	<u>\$ 19,340</u> Unfav.	<u>\$17,630</u> Unfav.	<u>\$ 7,990</u> Unfav.	<u>\$ 44,960</u> Unfav.

Solved Problems

8.1 Variance Analysis, Journal Entries. Operations of the Ralph Corporation are based on the following data: direct labor hours, 12,500; estimated overhead: fixed, \$5,000; variable, \$9,000.

Actual results were as follows: Direct labor hours, 9,300; overhead: fixed, \$5,075; variable, \$8,900.

There are 10,300 standard hours allowed for actual production.

Compute (a) the variable, fixed and total overhead rates, and (b) overhead variances using the three-variance method. Prepare (c) all necessary journal entries for the three-variance method.

SOLUTION

(a)

Variable rate:	$\$9,000 \div 12,500 = \$.72$
Fixed rate:	$\$5,000 \div 12,500 = .40$
Total rate:	$\$14,000 \div 12,500 = \underline{\underline{\$1.12}}$

(b) Variances

(1) Price (spending) variance:

$$\begin{aligned}
 \text{Price (spending) variance} &= \text{Actual factory overhead} - \text{Budgeted factory overhead at actual direct labor hours worked} \\
 &= \$13,975 - [(9,300 \times \$0.72) + \$5,000] \\
 &= \$13,975 - \$11,696 \\
 &= \$ 2,279 \text{ Unfav.}
 \end{aligned}$$

(2) *Efficiency variance:*

$$\begin{aligned}
 \text{Efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{direct} \\ \text{labor} \\ \text{hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct} \\ \text{labor} \\ \text{hours} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard} \\ \text{variable} \\ \text{factory} \\ \text{overhead} \\ \text{application} \\ \text{rate} \end{array} \\
 &= (9,300 - 10,300) \times \$0.72 \\
 &= 1,000 \times \$0.72 \\
 &= (\$720) \text{ Fav.}
 \end{aligned}$$

(3) *Production volume (denominator or idle capacity) variance:*

$$\begin{aligned}
 \text{Production volume (denominator or idle capacity) variance} &= \left(\begin{array}{c} \text{Denominator} \\ \text{direct} \\ \text{labor} \\ \text{hours} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct} \\ \text{labor} \\ \text{hours} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard} \\ \text{fixed} \\ \text{factory} \\ \text{overhead} \\ \text{application} \\ \text{rate} \end{array} \\
 &= (12,500 - 10,300) \times \$0.40 \\
 &= 2,200 \times \$0.40 \\
 &= \$880 \text{ Unfav.}
 \end{aligned}$$

(c)

Factory Overhead Applied (10,300 hours × \$1.12)	11,536
Factory Overhead Price Variance	2,279
Factory Overhead Production Volume Variance	880
Factory Overhead Efficiency Variance	720
Factory Overhead Control	13,975

8.2 Variance Analysis. Hardwood Furniture, Incorporated manufactures all types of office furniture. The company has one giant plant and office complex in California, and employs a full-time cost accounting department to control and analyze production costs. At the end of the year, the cost accounting department showed the following data: The factory overhead rate is

based on a normal capacity of 8,000 hours. Total budgeted factory overhead expenses were \$11,560, consisting of variable expenses, \$4,960, and fixed expenses, \$6,600.

The standard cost card showed:

Direct materials	\$5.00 per unit
Direct labor	4.00 per hour

Actual Data

<i>Materials: Purchased</i>	10,000 units @ \$4.94
Requisitioned	7,100 units
Standard quantity allowed	7,000 units
<i>Direct labor: Actual hours worked</i>	3,760 hours
Standard hours allowed	3,180 hours
Actual rate paid	\$4.20 per hour
<i>Factory overhead (actual):</i>	\$10,994

Compute the variances for (a) direct materials, (b) direct labor, and (c) factory overhead, showing (1) computation of overhead rates and (2) variances using the three-factor analysis.

SOLUTION

(a) (1) Direct Materials Price Variance

$$\begin{aligned}\text{Direct materials price variance} &= \left(\begin{array}{cc} \text{Actual} & \text{Standard} \\ \text{unit} & \text{unit} \\ \text{price} & \text{price} \end{array} \right) \times \text{Actual quantity purchased} \\ &= (\$4.94 - \$5.00) \times 10,000 \\ &= \$0.06 \times 10,000 \\ &= (\$600) \text{ Fav.}\end{aligned}$$

(2) Direct Materials Efficiency Variance

$$\begin{aligned}
 \text{Direct materials efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{quantity} \\ \text{used} \end{array} - \begin{array}{c} \text{Standard} \\ \text{quantity} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard} \\ \text{unit} \\ \text{price} \end{array} \\
 &= (7,100 - 7,000) \times \$5.00 \\
 &= 100 \times \$5.00 \\
 &= \$500 \text{ Unfav.}
 \end{aligned}$$

(b) (1) Direct Labor Price Variance

$$\begin{aligned}
 \text{Direct labor price variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{hourly} \\ \text{wage rate} \end{array} - \begin{array}{c} \text{Standard} \\ \text{hourly} \\ \text{wage rate} \end{array} \right) \times \begin{array}{c} \text{Actual number} \\ \text{of direct labor} \\ \text{hours worked} \end{array} \\
 &= (\$4.20 - \$4.00) \times 3,760 \\
 &= \$1.20 \times 3,760 \\
 &= \$752 \text{ Unfav.}
 \end{aligned}$$

(2) Direct Labor Efficiency Variance

$$\begin{aligned}
 \text{Direct labor efficiency variance} &= \left(\begin{array}{c} \text{Actual direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard direct} \\ \text{labor hours} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard direct} \\ \text{labor hourly} \\ \text{wage rate} \end{array} \\
 &= (\$3,760 - 3,180) \times \$4.00 \\
 &= 580 \times \$4.00 \\
 &= \$2,320 \text{ Unfav.}
 \end{aligned}$$

(c) (1) Overhead Rates

$$\begin{aligned}
 \text{Fixed rate: } & \$6,600 \div 8,000 = \$.825 \\
 \text{Variable rate: } & \$4,960 \div 8,000 = \underline{.620} \\
 \text{Total overhead rate: } & \underline{\underline{\$1.445}}
 \end{aligned}$$

(2) Three-factor Analyses

Price (spending) variance

$$\begin{aligned}
 \text{Price (spending) variance} &= \begin{array}{c} \text{Actual} \\ \text{factory} \\ \text{overhead} \end{array} - \begin{array}{c} \text{Budgeted factory overhead} \\ \text{at actual direct} \\ \text{labor hours worked} \end{array} \\
 &= \$10,994 - [(3,760 \times \$0.62) + \$6,600] \\
 &= \$10,994 - \$8,931.20 \\
 &= \$2,062.80 \text{ Unfav.}
 \end{aligned}$$

Efficiency variance

$$\begin{aligned}
 \text{Efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct} \\ \text{labor hours} \\ \text{allowed} \end{array} \right) \times \begin{array}{c} \text{Standard variable} \\ \text{factory overhead} \\ \text{application rate} \end{array} \\
 &= (3,760 - 3,180) \times \$0.62 \\
 &= 580 \times \$0.62 \\
 &= \$359.60 \text{ Unfav.}
 \end{aligned}$$

Production volume (denominator or idle capacity) variance

$$\begin{aligned}
 \text{Production volume} & \\
 \text{(denominator or idle} & \\
 \text{capacity) variance} &= \left(\begin{array}{c} \text{Denominator} \\ \text{direct labor} \\ \text{hours} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct labor} \\ \text{hours allowed} \end{array} \right) \times \begin{array}{c} \text{Standard fixed} \\ \text{factory overhead} \\ \text{application rate} \end{array} \\
 &= (8,000 - 3,180) \times \$0.825 \\
 &= 4,820 \times \$0.825 \\
 &= \$3,976.50 \text{ Unfav.}
 \end{aligned}$$

8.3 Factory Overhead Variances; Journal Entries. From the data below prepare (a) an analysis of factory overhead variances using (1) the two-variance method and (2) the three-variance method, and (b) journal entries for the three-variance analysis.

	(normal capacity)	Actual
Direct labor hours	20,000	25,600
Factory overhead:		
Fixed	\$14,000	\$17,000
Variable	16,000	19,000
Standard allowed for actual production: 24,000 hours		

SOLUTION

(a) (1) **Factory Overhead Variance—Two-factor Analysis**

$$\begin{aligned}
 \text{Budget (controllable) variance} &= \begin{array}{c} \text{Actual} \\ \text{factory} \\ \text{overhead} \end{array} - \begin{array}{c} \text{Budgeted factory overhead} \\ \text{at standard direct} \\ \text{labor hours allowed} \end{array} \\
 &= \$36,000 - \left[\left(\frac{16,000}{20,000} \times 24,000 \right) + \$14,000 \right] \\
 &= \$36,000 - \$33,200 \\
 &= \$2,800 \text{ Unfav.}
 \end{aligned}$$

Production volume (denominator or idle capacity) variance

$$\begin{aligned}
 \text{Production volume (denominator or idle capacity) variance} &= \left(\begin{array}{c} \text{Denominator} \\ \text{direct labor} \\ \text{hours} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct labor} \\ \text{hours allowed} \end{array} \right) \times \text{Standard fixed factory overhead application rate} \\
 &= (20,000 - 24,000) \times \$0.70^* \\
 &= -4,000 \times \$0.70 \\
 &= (\$2,800) \text{ Fav.}
 \end{aligned}$$

* $(\$14,000 \div 20,000 \text{ hours})$

(2) Factory Overhead Variance—Three-factor Analysis

$$\begin{aligned}
 \text{Price (spending) variance} &= \text{Actual factory overhead} - \text{Budgeted factory overhead at actual direct labor hours worked} \\
 &= \$36,000 - [(\$0.80^* \times 25,600) + \$14,000] \\
 &= \$36,000 - \$34,480 \\
 &= \$1,520 \text{ Unfav.}
 \end{aligned}$$

* $\$16,000 \div 20,000 \text{ dlh}$

Efficiency variance

$$\begin{aligned}
 \text{Efficiency variance} &= \left(\begin{array}{c} \text{Actual} \\ \text{direct} \\ \text{labor hours} \\ \text{worked} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct} \\ \text{labor hours} \\ \text{allowed} \end{array} \right) \times \text{Standard variable factory overhead application rate} \\
 &= (25,600 - 24,000) \times \$0.80 \\
 &= 1,600 \times \$0.80 \\
 &= \$1,280 \text{ Unfav.}
 \end{aligned}$$

Production volume (denominator or idle capacity) variance

$$\begin{aligned}
 \text{Production volume (denominator or idle capacity) variance} &= \left(\begin{array}{c} \text{Denominator} \\ \text{direct labor} \\ \text{hours} \end{array} - \begin{array}{c} \text{Standard} \\ \text{direct labor} \\ \text{hours allowed} \end{array} \right) \times \text{Standard fixed factory overhead application rate} \\
 &= (20,000 - 24,000) \times \$0.70 \\
 &= -4,000 \times \$0.70 \\
 &= (\$2,800) \text{ Fav.}
 \end{aligned}$$

(b) Journal Entries

Factory Overhead Applied	36,000*
Factory Overhead Price Variance	1,520
Factory Overhead Efficiency Variance	1,280
Factory Overhead Production Volume Variance	2,800
Factory Overhead Control	36,000

* (24,000 standard hours allowed × \$1.50 factory overhead application rate)

8.4 Gross Profit Analysis. The following data pertain to the R. W. Mauro Company: *R. W. Mauro Company*

	Budget	Actual	Change	Percent
Sales	\$65,000	\$69,000	\$ + 4,000	6.2%
Cost of goods sold	<u>50,000</u>	<u>53,000</u>	<u>+ 3,000</u>	<u>6.0%</u>
Gross profit	<u>\$15,000</u>	<u>\$16,000</u>	<u>\$ 1,000</u>	<u>6.7%</u>
Gross profit ratio	<u>23.1%</u>	<u>23.2%</u>		

Cost Data per Unit

	Budget	Actual	Change
	(5,000 Units)	(5,520 Units)	(+ 520 Units)
Sales price	\$13.00	\$12.50	\$ - 0.50
Cost	<u>10.00</u>	<u>9.60</u>	<u>- 0.40</u>
Gross profit	<u>\$ 3.00</u>	<u>\$ 2.90</u>	<u>\$ - 0.10</u>

Compute (a) the volume variance, the sales variance, and the cost variance; and (b) their combined effect on gross profit.

SOLUTION

$$\begin{aligned}
 (a) \quad \text{Volume variance} &= \left(\begin{array}{c} \text{Budgeted} \\ \text{volume} \end{array} - \begin{array}{c} \text{Actual} \\ \text{volume} \end{array} \right) \times \begin{array}{c} \text{Budgeted gross} \\ \text{profit per unit} \end{array} \\
 &= (5,000 - 5,520) \times \$3 \\
 &= -520 \times \$3 \\
 &= (\$1,560) \text{ Fav.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Sales price} &= \left(\begin{array}{c} \text{Budgeted} \\ \text{sales price} \\ \text{per unit} \end{array} - \begin{array}{c} \text{Actual sales} \\ \text{price per unit} \end{array} \right) \times \begin{array}{c} \text{Actual} \\ \text{volume} \end{array} \\
 \text{variance} &= (\$13.00 - \$12.50) \times 5,520 \\
 &= \$0.50 \times 5,520 \\
 &= \$2,760 \text{ Unfav.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Cost variance} &= \left(\begin{array}{c} \text{Budgeted cost} \\ \text{per unit} \end{array} - \begin{array}{c} \text{Actual cost} \\ \text{per unit} \end{array} \right) \times \begin{array}{c} \text{Actual} \\ \text{volume} \end{array} \\
 &= (\$10.00 - \$9.60) \times 5,520 \\
 &= \$0.40 \times 5,520 \\
 &= (\$2,208) \text{ Fav.}
 \end{aligned}$$

(b) Summary

Volume variance	(\$1,560) Fav.
Sales price variance	2,760 Unfav.
Cost variance	<u>(2,208) Fav.</u>
Total	<u><u>(\$1,008) Fav.</u></u>

8.5 Multiproduct Gross Profit Analysis. Following are the budgeted and actual gross profit data for McHandy Company. Prepare a gross profit analysis assuming that products S, K, and L can be substituted for each other.

McHandy Company
Budgeted Gross Profit Statement
Year 19XX

Product	Units Sold	Sales		Cost		Gross Profit		
		Price	Amount	Unit	Amount	Unit	Amount	Percent
S	5,500	\$4.75	\$26,125	\$3.50	\$19,250	\$1.25	\$ 6,875	26.3%
K	4,500	3.00	13,500	2.50	11,250	0.50	2,250	16.7%
L	2,200	4.75	10,450	4.00	8,800	0.75	1,650	15.8%
Total	12,200	\$4.10	\$50,075	\$3.22	\$39,300	\$0.88	\$10,775	21.5%

McHandy Company
Actual Gross Profit Statement
Year 19XX

Product	Units Sold	Sales		Cost		Gross Profit		
		Price	Amount	Unit	Amount	Unit	Amount	Percent
S	6,000	\$5.00	\$30,000	\$3.25	\$19,500	\$1.75	\$10,500	35.0%
K	4,000	3.25	13,000	2.75	11,000	.50	2,000	15.4%
L	2,000	4.50	9,000	3.75	7,500	0.75	1,500	16.6%
Total	12,000	\$4.34	\$52,000	\$3.17	\$38,000	\$1.17	\$14,000	26.9%

SOLUTION

Pure Volume Variance

Product S**Product K****Product L** $(5,500 - 6,000)$ $\times \$0.88$ $- 500 \times \$0.88$ $(\$440) \text{ Fav.}$ $(4,500 - 4,000)$ $\times \$0.88$ $500 \times \$0.88$ $\$440 \text{ Unfav.}$ $(2,200 - 2,000)$ $\times \$0.88$ $200 \times \$0.88$ $\$176 \text{ Unfav.}$ **Mix Variance****Product S****Product K****Product L** $(5,500 - 6,000)$ $(4,500 - 4,000)$ $(2,200 - 2,000)$ $\times (\$0.88 - \$1.25)$ $\times (\$0.88 - \$0.50)$ $\times (\$0.88 - \$0.75)$ $- 500 \times \$0.37$ $500 \times \$0.38$ $200 \times \$0.13$ $(\$185) \text{ Fav.}$ $(\$190) \text{ Fav.}$ $(\$26) \text{ Fav.}$ **Sales Price Variance****Product S****Product K****Product L** $(\$4.75 - \$5.00)$ $(\$3.00 - \$3.25)$ $(\$4.75 - \$4.50)$ $\times 6,000$ $\times 4,000$ $\times 2,000$ $-\$0.25 \times 6,000$ $-\$0.25 \times 4,000$ $\$0.25 \times 2,000$ $(\$1,500) \text{ Fav.}$ $(\$1,000) \text{ Fav.}$ $\$500 \text{ Unfav.}$ **Cost Variance**

Product S

$$(\$3.50 - \$3.25)$$

$$\times 6,000$$

$$\$0.25 \times 6,000$$

$$(\$1,500) \text{ Fav.}$$
Product K

$$(\$2.50 - \$2.75)$$

$$\times 4,000$$

$$-\$0.25 \times 4,000$$

$$\$1,000 \text{ Unfav.}$$
Product L

$$(\$4.00 - \$3.75)$$

$$\times 2,000$$

$$\$0.25 \times 2,000$$

$$(\$500) \text{ Fav.}$$
Summary of Variances

	Product S	Product K	Product L	Total
Pure volume variance	\$ (440) Fav.	\$ 440 Unfav.	\$ 176 Unfav.	\$ 176 Unfav.
Mix variance	(185) Fav.	(190) Fav.	(26) Fav.	(401) Fav.
Sales price variance	(1,500) Fav.	(1,000) Fav.	500 Unfav.	(2,000) Fav.
Cost variance	<u>(1,500)</u> Fav.	<u>1,000</u> Unfav.	<u>(500)</u> Fav.	<u>(1,000)</u> Fav.
Total	<u><u>\$(3,625)</u></u> Fav.	<u><u>\$ 250</u></u> Unfav.	<u><u>\$ 150</u></u> Unfav.	<u><u>\$(3,225)</u></u> Fav.

Chapter 9

Direct Costing, Break-Even Analysis, and Cost-Volume-Profit Planning

Direct Costing

9.1 MEANING OF DIRECT COSTING

Under absorption costing, all production costs (direct materials, direct labor, and factory overhead—both variable and fixed) are treated as product costs.

Under direct costing, only the production costs that vary with volume (direct materials, direct labor, and variable factory overhead) are treated as product costs. Fixed factory overhead is treated as a period cost.

9.2 DIRECT COSTING: PRODUCT AND PERIOD COSTS

Direct costing makes a distinction between *product costs* and *period costs*. Product costs consist only of prime costs for direct materials and direct labor plus variable factory overhead. These are the costs assigned to inventories (work in process and finished goods) and cost of goods sold. Fixed factory overhead is included with other period expenses, such as selling and administrative expenses.

Thus, the primary difference between direct costing and absorption costing is the treatment of fixed factory overhead. Direct costing excludes it as a product cost; absorption costing includes it as a product cost in inventories and cost of goods sold.

9.3 DIRECT COSTING VS. ABSORPTION COSTING: INCOME STATEMENTS

The conceptual differences between income statements prepared under direct costing and absorption costing procedures are as follows: (1) ***Gross marginal income vs. gross profit***. Under direct costing, the gross marginal income figure represents the difference between sales and variable manufacturing costs. It is the equivalent of the gross profit figure under absorption costing, and reflects the exclusion of fixed costs from inventory valuation and cost of goods sold. Thus, gross marginal income will always be greater than gross profit. It is also important to note that this method allows the cost of goods sold to vary directly with sales.

(2) ***Contribution margin***. Also known as marginal income, the contribution margin is the excess of sales over total variable costs (i.e., manufacturing, selling, administrative). Its usefulness

as a profit planning device makes this a significant feature of the direct costing income statement (see [Section 9.4](#)).

- (3) ***Inventory costs***. Under direct costing, fixed overhead is eliminated from inventories. This is contrary to the AICPA's view; *ARB No. 43* specifically states that "... exclusion of all overheads from inventory costs does not constitute an accepted accounting procedure." Neither the IRS nor the SEC will accept direct costing until the Financial Accounting Standards Board approves its use. As a result, many firms use direct costing for internal reports but adjust inventories to conform with absorption costing procedures for external reports.
- (4) ***Net operating profit (NOP)***. The difference in net operating profit under the two methods is due to the amount of fixed costs charged to inventories. If there are no beginning or ending inventories, the NOP under both methods will be the same.

EXAMPLE 1

The standard and actual data for the Broadway Company used in [Chapter 8](#) are summarized below. These data are used to illustrate the cost of goods manufactured statement and the income statement, using both absorption costing and direct costing.

Standard unit cost:

Direct materials	\$48.00	
Direct labor	18.00	
Factory overhead:		
Variable	3.00	
Fixed	<u>4.00</u>	\$ 73.00

Budgeted fixed factory overhead

\$ 8,000

Standard costs put into production:

Direct materials (2,000 × \$48)	\$96,000
Direct labor (1,900 × \$18)	34,200
Factory overhead:	
Variable (1,900 × \$3)	5,700
Fixed (1,900 × \$4)	7,600

Ending work-in-process inventory (100 units):

Direct materials (100 × \$48)	4,800
Direct labor (100 × \$18 × 50%)	900
Factory overhead:	
Variable (100 × \$3 × 50%)	150
Fixed (100 × \$4 × 50%)	200

Units in ending finished goods inventory:

Units started and completed	1,900	
Units sold	<u>1,500</u>	400

Variances:

Direct materials price		\$12,500 Unfav.	
Direct materials efficiency		8,000 Fav.	
Direct labor price		4,914 Unfav.	
Direct labor efficiency		900 Unfav.	
Factory overhead:			
Budget	-0-		
Production volume	<u>\$ 400 Unfav.</u>	<u>400 Unfav.</u>	\$ 10,714 Unfav.

Marketing and administrative expense

(assume \$500 are fixed costs) \$ 1,500

Sales (1,500 × \$400) \$600,000

Assume there are no opening inventories: variances are not prorated but charged to cost of goods sold: ignore income taxes.

Broadway Company
Cost of Goods Manufactured

Absorption Costing

Costs put into production during the period at standard:		
Direct materials		\$ 96,000
Direct labor		34,200
Factory overhead:		
Variable	\$5,700	
Fixed	<u>7,600</u>	<u>13,300</u>
Total costs put into production at standard		143,500
Plus: Work-in-process inventory at beginning of the period		<u>-0-</u>
Cost of goods in process during the period at standard		\$143,500
Less: Work-in-process inventory at the end of the period at standard		<u>6,050 (a)</u>
Cost of goods manufactured at standard		<u><u>\$137,450</u></u>

Direct Costing

Variable costs put into production during the period at standard:	
Direct materials	\$ 96,000
Direct labor	34,200
Variable factory overhead	<u>5,700</u>
Total variable costs put into production at standard	\$135,900
Plus: Variable work-in-process inventory at beginning of the period	<u>-0-</u>
Variable cost of goods in process during the period at standard	\$135,900
Less: Variable work-in-process inventory at the end of the period at standard	<u>5,850 (b)</u>
Variable cost of goods manufactured at standard	<u><u>\$130,050</u></u>

(a) Work-in-process inventory at the end of the period:

Direct materials		\$4,800
Direct labor		900
Factory overhead:		
Variable	\$150	
Fixed	<u>200</u>	<u>350</u>
Total		<u><u>\$6,050</u></u>

Direct materials	\$4,800
Direct labor	900
Factory overhead:	
Variable	<u>150</u>
Total	<u><u>\$5,850</u></u>

(b) Work-in-process inventory at the end of the period:

Note the difference in the cost of goods manufactured between the two methods:

<i>Amount:</i> Absorption costing	\$137,450
Direct costing	<u>130,050</u>
Difference	<u><u>\$ 7,400</u></u>

Analysis: The difference is due to fixed costs included in absorption costing but not included in

	Fixed costs put into production	\$7,600
	Less: Fixed costs in ending work-in-process inventory	<u>200</u>
	Net fixed costs included in production (absorption costing only)	<u><u>\$7,400</u></u>
direct costing as follows:		

Broadway Company
Income Statement

Absorption Costing

Sales		\$600,000
Cost of goods sold:		
Opening finished goods inventory	-0-	
Plus: Cost of goods manufactured at standard	\$137,450	
Net total unfavorable variances	<u>10,714</u>	
Goods available for sale	\$148,164	
Less: Closing finished goods inventory at standard (400 × \$73)	<u>29,200</u>	
Cost of goods sold		<u>118,964</u>
Gross profit		\$481,036
Less: Marketing and administrative expenses		<u>1,500</u>
Operating income		<u><u>\$479,536</u></u>

Direct Costing

Sales		\$600,000
Variable cost of goods sold:		
Opening finished goods inventory	\$-0-	
Plus: Variable cost of goods manufactured at standard	130,050	
Net unfavorable variances	<u>10,314 (c)</u>	
Goods available for sale	\$140,364	
Less: Closing finished goods inventory at standard		
[400 × \$69 (d)]	<u>27,600</u>	
Variable cost of goods sold	\$112,764	
Plus: Variable marketing and administrative expenses	<u>1,000</u>	
Total variable costs		<u>113,764</u>
Contribution margin		\$486,236
Less: Budgeted fixed factory overhead	8,000	
Fixed marketing and administrative expenses	<u>500</u>	<u>8,500</u>
Operating income		<u><u>\$477,736</u></u>

(c) \$10,714 total variance – \$400 production volume variance = \$10,314

(d) \$73 standard unit cost – \$4 fixed factory overhead application rate = \$69

Note the difference between the two methods:

<i>Amount:</i> Absorption costing	\$479,536
Direct costing	<u>477,736</u>
Difference	<u><u>\$ 1,800</u></u>

Analysis: The difference is due to the amount of fixed factory overhead included in inventories under absorption costing but not under direct costing:

	Work-in- Process	Finished Goods	Totals
Absorption costing	\$6,050	\$29,200	\$35,250
Direct costing	<u>5,850</u>	<u>27,600</u>	<u>33,450</u>
Difference	<u><u>\$ 200</u></u>	<u><u>\$ 1,600</u></u>	<u><u>\$ 1,800</u></u>

9.4 USES OF DIRECT COSTING

By distinguishing between product and period costs, direct costing offers a variety of uses for both internal and external purposes. Some of the benefits accruing from this costing method are described below.

Direct costing is a useful analytic device in budget preparation, since such *profit planning* involves both short-and long-run operations. The isolation of product costs emphasizes the cost-volume-profit relationship, providing data for such planning problems as breakeven analysis, return on investment, *etc.*

The simplified techniques associated with the contribution margin also make direct costing a useful tool for product pricing; managerial decisions related to production levels, new products and markets, special activities, *etc.* Finally, as a control tool, direct costing facilitates the preparation of responsibility-based income statements for managers, enabling them to recognize and act upon discrepancies and variances occurring in their areas.

The separation of accounts into fixed and variable components under direct costing simplifies the processes of assigning costs to inventory and determining income. It allows net income to vary more directly with sales since no fixed costs are deferred in inventories. It also results in clear, easily understood financial reports. Finally, direct costing guards against profit manipulation. It reduces the possibility of having increased sales with decreased earnings because fixed expenses are considered period, not product, costs. With fixed overhead costs remaining constant, an increase in sales will increase profits.

9.5 ADVANTAGES AND DISADVANTAGES OF DIRECT COSTING

Advantages of Direct Costing

- (1) Establishes cost-volume-profit relationships.
- (2) Excludes fixed overhead from inventories, which both simplifies the report and leaves it less open to misinterpretation by management.
- (3) Makes the impact of fixed overhead on management more effective because fixed overhead is shown as a separate charge.
- (4) Provides a basis for comparison of the profitability of different products.
- (5) Conforms to the concept of assigning current out-of-pocket expenditures to the cost of manufacturing a product.

Disadvantages of Direct Costing

- (1) Makes no clear-cut distinction between fixed and variable overhead costs—many are hybrid.
- (2) Violates the principle that manufacturing cost should include all manufacturing charges, including fixed overhead.
- (3) Allows an item to be fixed or variable, depending on the (depreciation) method used.
- (4) Is not in accordance with the tax laws and generally accepted accounting principles.
- (5) Cannot be used for long-range pricing policies, which must include fixed overhead as part of cost.

BreakEven Analysis

9.6 USE OF BREAKEVEN ANALYSIS

Breakeven analysis provides a concise presentation of the relationship between cost and volume changes and the effect of such changes on profit. The *breakeven point* is the sales volume or other appropriate base at which *total revenue equals total costs, resulting in neither a profit nor a loss*. Although the breakeven point is important, its usefulness is limited by the assumptions on which it is based and the short time during which the data used may be valid. Although management is interested primarily in the profit at various levels of operation, management must also know the effect on profit of changes in sales price or volume and variable or fixed costs.

The principal breakeven analysis methods are the (1) equation method, (2) contribution-margin method, and (3) graphic method. Their results are generally expressed in dollars or units.

Basic Data Used. To make comparisons possible, the various methods will be illustrated by using the same basic data. Company A manufactures an electronic device and sells it for \$5 a unit, with a variable cost of \$3 per unit. Sales volume and any other variables will be given in each example.

9.7 EQUATION METHOD

The method in general use is the equation or algebraic method. It is based on the income statement equation: Sales – Variable costs – Fixed costs = Profit

For calculating the breakeven point the equation is restated as:

$$\text{Sales} = \text{Variable costs} + \text{Fixed costs} + \text{Profit}$$

Note that the profit at the breakeven point will be zero.

EXAMPLE 2

Find the number of units that must be sold to break even with fixed costs of \$800. Substituting the basic data in the equation and solving for x , the number of units needed, we have:

$$\$5x = \$3x + \$800 + 0$$

$$\$2x = \$800$$

$$x = 400 \text{ units}$$

Replacing x with 400 units gives:

$$\text{Sales} = \text{Variable costs} + \text{Fixed costs} + \text{Profit}$$

$$\$2,000 = \$1,200 + \$800 + 0$$

Thus it takes sales of 400 units, or \$2,000, to break even.

9.8 CONTRIBUTION MARGIN METHOD

The *contribution margin* is the excess of sales over variable costs. The contribution is applied first to fixed costs, and any excess is considered profit. The breakeven point under this method is stated

as:
$$\text{Break-even point} = \frac{\text{Fixed costs}}{\text{Contribution margin}}$$

When the contribution margin per unit is used, the breakeven point in units results. For a breakeven point in dollars the contribution margin as a percentage of sales (contribution margin per unit divided by the selling price per unit) must be used.

EXAMPLE 3

Assuming a fixed cost of \$800, the breakeven point in (a) units and (b) dollars is calculated as follows:

(a)

$$\frac{\$800}{\$5 - \$3} = 400 \text{ units}$$

(b) The contribution margin as percentage of sales is:

$$\frac{\$2}{\$5} = 40\%$$

The breakeven point in dollars then is:

$$\frac{\$800}{40\%} = \$2,000$$

9.9 GRAPHIC METHOD

The graphic method affords a concise, easy-to-understand picture of the cost-volume-profit relationship of the firm. Information about sales, total costs, variable and fixed costs, and profit at any given volume can be easily read from the chart. Therefore, breakeven charts are an especially effective means of presenting data when management lacks familiarity with interpreting detailed statistical or financial reports.

Many pages of detailed data can be presented in a single breakeven chart. Although the focus often is on the breakeven point, where the total sales revenue line and the total cost line intersect, this is not the most important information on the breakeven chart. Management is usually more interested in seeing the relationship of costs and revenue to profit at various volume levels.

In constructing the chart, certain factors and their behavior must be considered. For example, total sales and total variable costs change in direct proportion to changes in volume. However, such cost-volume-profit relationships are valid only within the prescribed limits, defined as the *relevant range*. The chart may not be valid for volumes outside the limits.

The breakeven charts in [Examples 4](#) and [5](#) are the two principal types generally in use. Although more sophisticated charts are sometimes presented, their interpretation often requires previous experience with breakeven charts. [Example 4](#) shows a breakeven chart in which fixed costs are parallel to the horizontal line and *below variable costs*. [Example 5](#) shows the type of chart in which fixed costs are shown *above variable costs*.

EXAMPLE 4 FIXED COSTS SHOWN BELOW VARIABLE COSTS ([Fig. 9.1](#))

Relevant range

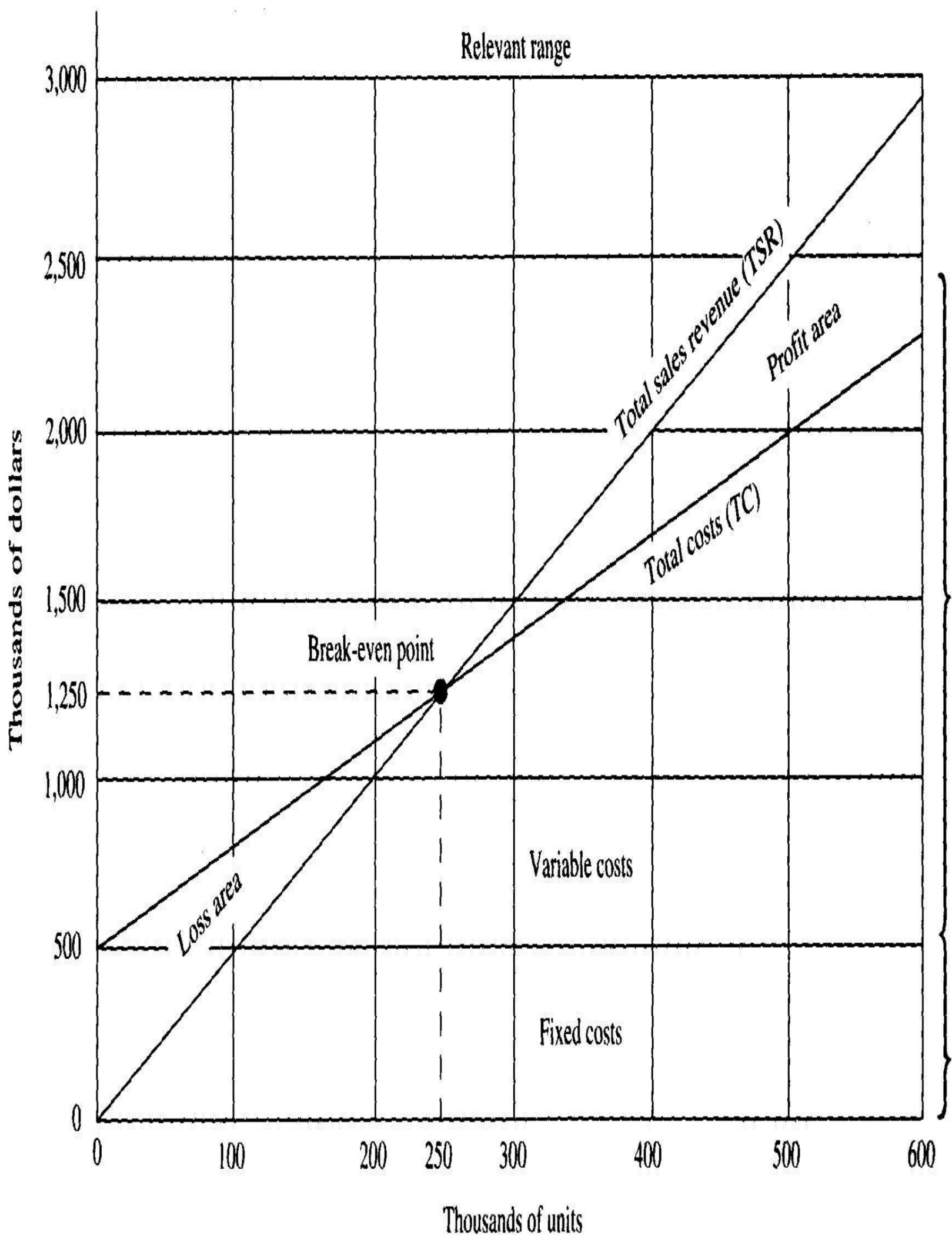


Fig. 9-1

The basic data (\$5 sales price per unit and \$3 variable cost per unit) still apply. The relevant range is from 1 to 600,000 units. Fixed costs are assumed to be \$500,000. The following steps are used to construct a breakeven chart.

Step 1: Total Sales Revenue Line. Choose any number of units greater than zero on the horizontal line and multiply by the selling price per unit (\$5). The result will equal total sales revenue (TSR) for that number of units. For example, choosing 300,000 units will result in \$1,500,000 TSR. Because the chart is in thousands, this point is plotted at the coordinate (\$1,500;300). Other points are plotted similarly. A straight line representing TSR is then drawn through the points.

Step 2: Total Costs Line. The total costs (TC) line represents the sum of fixed costs and variable costs at any particular point on the chart. Fixed costs are \$500,000 in this example and are assumed to remain unchanged from 1 to 600,000 units (the relevant range). Variable costs are \$3 per unit. At 300,000 units

$$\text{Total variable costs} = 300,000 \text{ units} \times \$3 \text{ per unit} = \$900,000$$

the calculations are: **Total costs = \$500,000 fixed + \$900,000 variable = \$1,400,000**

A point is then plotted at (\$1,400;300). Total costs at other volumes are plotted similarly. A straight line representing TC is then drawn from \$500 (= \$500,000) on the vertical axis (fixed-cost portion) through the points.

Step 3: BreakEven Point. The total costs line (TC) intercepts the total sales revenue line (TSR) at the breakeven point.

As [Fig. 9-1](#) shows, the breakeven point is at a volume of 250,000 units. Here the sales are \$1,250,000, total costs are \$1,250,000, variable costs are \$750,000 (\$1,250,000 - \$500,000), fixed costs are \$500,000, and the profit, of course, is zero. Any level of activity below 250,000 units will fall in the loss area shown in the chart, and any level of activity above 250,000 units will fall in the profit area.

Initially, the various relationships depicted on the chart may be more easily understood if the data are shown in tabulated form as follows:

Tabulation of Fig. 9-1 Data

	Thousands					Per Unit		
	Sales at \$5	Variable Costs at \$3	Fixed Costs	Total Costs	Profit (Loss)	Total Costs	Profit (Loss)	Profit (Loss), %*
Units								
100	\$ 500	\$ 300	\$500	\$ 800	\$(300)	\$8.00	\$ (3.00)	(60)
200	1,000	600	500	1,100	(100)	5.50	(0.50)	(10)
250†	1,250	750	500	1,250	0	5.00	0	
300	1,500	900	500	1,400	100	4.67	0.33	6.7
400	2,000	1,200	500	1,700	300	4.25	0.75	15
500	2,500	1,500	500	2,000	500	4.00	1.00	20
600	3,000	1,800	500	2,300	700	3.83	1.17	23.3

* Calculated as $\frac{\text{profit (loss)}}{\text{sales}} = \text{profit (loss), \%}$. For example, for 100,000 units, $\text{loss, \%} = \frac{\$300,000}{\$500,000} = 60\%$.

† Break-even point.

EXAMPLE 5 FIXED COSTS SHOWN ABOVE VARIABLE COST (Fig. 9.2)

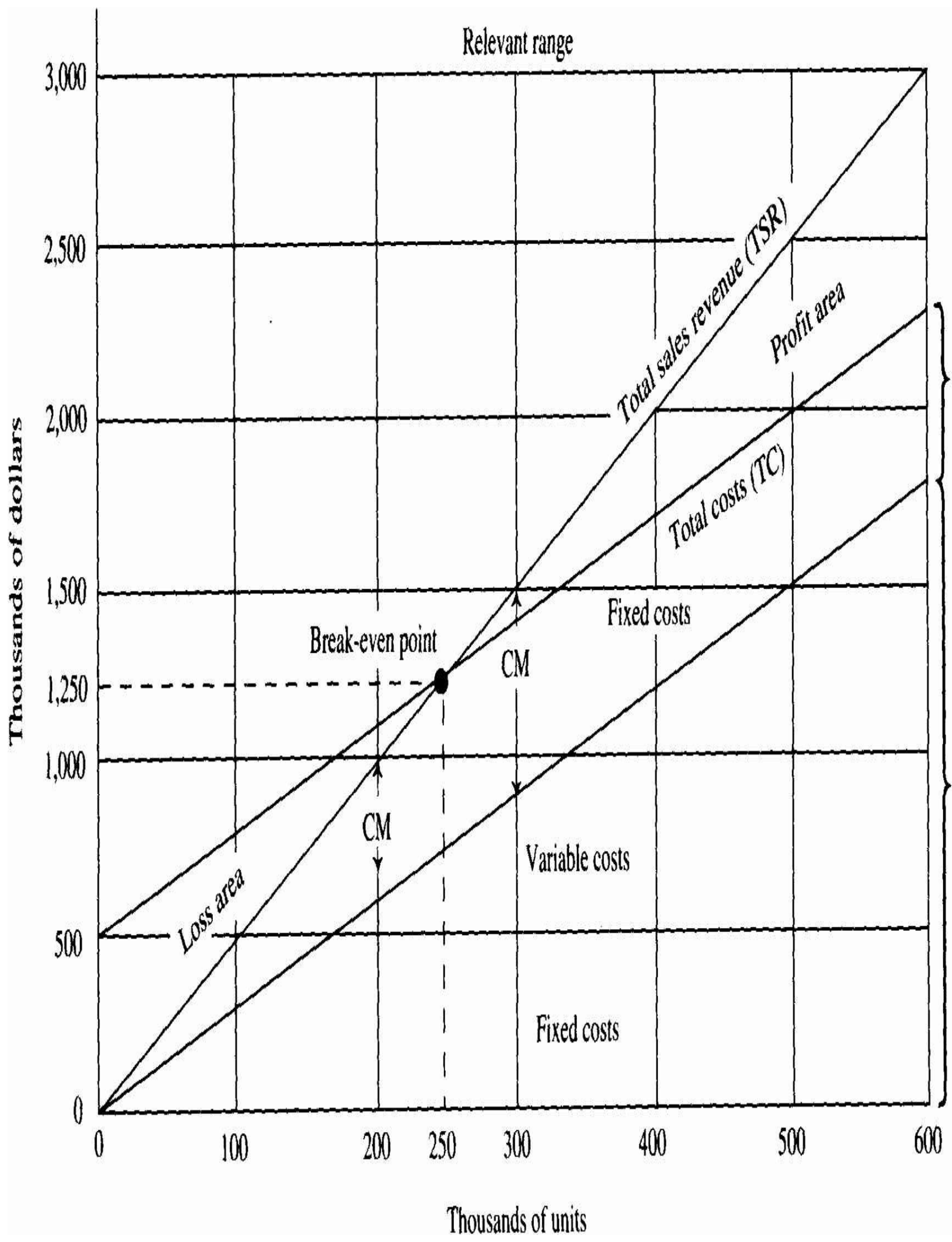


Fig. 9-2

In Fig. 9-1 the emphasis was on fixed costs remaining the same for all levels of activity. Many accountants prefer the approach in Fig. 9-2, which emphasizes the contribution margin (CM) for the various levels. The data are the same as in the previous tabulation except that the contribution margin is now shown.

Tabulation of Fig. 9-2 Data (Thousands)

Units	Sales at \$5	Variable Costs at \$3	Contribution Margin
100	\$ 500	\$ 300	\$ 200
200	1,000	600	400
250*	1,250	750	500
300	1,500	900	600
400	2,000	1,200	800
500	2,500	1,500	1,000
600	3,000	1,800	1,200

*** Break-even point.**

Note that the total sales revenue line and the total cost line are the same for both charts. The contribution margin shown by the tabulation can easily be read on the chart. For example, at 200,000 units the sales are \$1,000,000 and the variable costs \$600,000. The difference between the two, \$400,000, is the contribution margin at this level of activity. The area between the total sales revenue line and total costs line to the left of the breakeven point is that portion of fixed costs which is not covered by the contribution margin. The area between the total sales revenue line and the total costs line to the right of the breakeven point shows the amount of profit realized after fixed costs have been fully covered.

Cost-Volume-Profit Planning

9.10 USE OF COST-VOLUME-PROFIT PLANNING

Cost-volume-profit planning can be used by management in the following ways: (1) To determine the level of profit for a given level of sales.

$$\text{Profit} = \begin{array}{c} \text{Total} \\ \text{revenue} \end{array} - \begin{array}{c} \text{Total} \\ \text{variable} \\ \text{cost} \end{array} - \begin{array}{c} \text{Total} \\ \text{fixed} \\ \text{cost} \end{array}$$

The formula to determine profit for any level of sales is:

or

$$\text{Profit} = PQ - VQ - F$$

where:

P = Unit selling price

Q = Quantity

V = Variable cost

F = Fixed cost

For example, assuming the same data from [Example 5](#), if the level of sales is 8,000 units, the profit is:

$$\begin{aligned} \text{Profit} &= \$5 (8,000) - \$3 (8,000) - \$800 \\ &= \$15,200 \end{aligned}$$

(2) To determine the level of sales necessary to achieve a target profit.

The formula to determine the level of sales needed to achieve a target profit is:

$$\begin{array}{l} \text{Sales to realize} \\ \text{target profit (in units)} \end{array} = \frac{\text{Target profit} + \text{Total fixed costs}}{\text{Selling price per unit} - \text{Variable costs per unit}}$$

$$\begin{array}{l} \text{Sales to realize} \\ \text{target profit (in dollars)} \end{array} = \frac{\text{Target profit} + \text{Total fixed costs}}{1 - \text{Variable costs as a \% of dollar sales}}$$

EXAMPLE 6

Using data from [Example 2](#), and assuming that the target profit is \$25,000. then:

$$\begin{aligned} \text{Sales to realize} \\ \text{target profit (in units)} \end{aligned} &= \frac{\$25,000 + \$800}{\$5 - \$3} \\ &= 12,900 \text{ units} \end{aligned}$$

$$\begin{aligned} \text{Sales to realize} \\ \text{target profit (in dollars)} \end{aligned} &= \frac{\$25,000 + \$800}{1 - \$0.60 (a)} \\ &= \$64,500 \end{aligned}$$

(a) \$3 (variable cost) ÷ \$5 (selling price)

Adjustment for income taxes. To incorporate income taxes into the analysis, the formulas given above must be modified. Letting T denote the income tax rate, then:

$$\text{After-tax profit} = (1 - T) \cdot (PQ - VQ - F)$$

$$\begin{array}{l} \text{Sales to realize target} \\ \text{after-tax profit (in units)} \end{array} = \frac{\frac{\text{Target after-tax profit}}{(1 - T)} + \text{Total fixed costs}}{\text{Selling price per unit} - \text{Variable costs per unit}}$$

$$\begin{array}{l} \text{Sales to realize target} \\ \text{after-tax profit (in dollars)} \end{array} = \frac{\frac{\text{Target after-tax profit}}{(1 - T)} + \text{Total fixed costs}}{1 - \text{Variable costs as a \% of dollar sales}}$$

9.11 RISK AND PROFIT ANALYSIS

The margin of safety is a measure of the risk of not breaking even. It indicates by what percentage expected sales can decline and still allow the firm to break even. The higher the percentage, the smaller the risk of not realizing the breakeven point.

The formula for the margin of safety is

$$\text{Margin of safety} = \frac{\text{Expected sales} - \text{Break-even sales}}{\text{Expected sales}}$$

The formula is used for both the breakeven point in units, and dollars.

Suppose, for example, that the expected sales are 550 units. Recall that the breakeven point in

$$\text{Margin of safety} = \frac{550 - 400}{550}$$

units is 400. The margin of safety is: $= 27\%$

This means that if sales are 27% less than expected, the company will still break even.

To see that the formula is the same with dollars, recall that the selling price per unit is \$5. Since unit sales are expected to be 550, dollar sales are expected to be \$2,750 ($\5×550). The breakeven point in dollars is \$2,000.

$$\begin{aligned} \text{Margin of safety} &= \frac{\$2,750 - \$2,000}{\$2,750} \\ &= 27\% \end{aligned}$$

Solved Problems

9.1 Direct vs. Absorption Costing. The financial data for Meghan Company follows:

Production (in units)	10,000
Selling price (per unit)	\$40
Beginning inventory (units)	0
Ending inventory (units)	3,000
Costs per unit:	
Direct materials	\$5
Direct labor	\$10
Variable factory overhead	\$3
Fixed factory overhead	\$4
Selling and administrative expenses (\$2,000 fixed)	\$5,000

Prepare cost of goods manufactured statements under direct and absorption costing.

SOLUTION

Meghan Company
Cost of Goods Manufactured

Absorption Costing

Costs put into production during the period at standard:		
Direct materials		\$ 50,000
Direct labor		100,000
Factory overhead:		
Variable	\$30,000	
Fixed	40,000	70,000
	<u> </u>	<u> </u>
Total costs put into production at standard		\$220,000
Plus: Work-in-process inventory at beginning of the period		<u> -0- </u>
Cost of goods in process during the period at standard		\$220,000
Less: Work-in-process inventory at the end of the period at standard (\$22 × 3,000)		<u> 66,000 </u>
Cost of goods manufactured at standard		<u><u> \$154,000 </u></u>

Direct Costing

Variable costs put into production during the period at standard:	
Direct materials	\$ 50,000
Direct labor	100,000
Variable factory overhead	<u>30,000</u>
Total variable costs put into production at standard	\$180,000
Plus: Variable work-in-process inventory at beginning of the period	<u>-0-</u>
Variable cost of goods in process during the period at standard	\$180,000
Less: Variable work-in-process inventory at the end of the period at standard	<u>54,000 (a)</u>
Variable cost of goods manufactured at standard	<u><u>\$126,000</u></u>

(a) \$22 (Total cost per unit) – \$4 (fixed factory overhead) = \$18

$$\$18 \times 3,000 = \$54,000$$

9.2 BreakEven Analysis—Contribution-Margin Method. Using the following data, determine the breakeven point (BEP) in (a) units and (b) dollars for the K & B Corporation:

Sales price (SP) per unit	\$10
Fixed costs (FC)	\$200,000
Contribution margin (CM)	50% of sales

SOLUTION

$$(a) \quad \text{BEP (units)} = \frac{\text{FC}}{\text{CM per unit}^*} = \frac{\$200,000}{\$5 \text{ per unit}} = 40,000 \text{ units}$$

$$* \text{ CM per unit} = \text{SP per unit} \times \text{CM}\% = \$10 \times 50\% = \$5.$$

$$(b) \quad \text{BEP (dollars)} = \text{SP per unit} \times \text{BEP (units)} = \$10 \times 40,000 \text{ units} = \$400,000$$

$$\text{or} \quad \text{BEP (dollars)} = \frac{\text{FC}}{\text{CM}\%} = \frac{\$200,000}{50\%} = \$400,000$$

9.3 BreakEven Analysis—Graphic Method. Using the data given for the K&B Corporation in Prob. 9.2, illustrate the breakeven point on a graph with fixed costs below variable costs.

SOLUTION

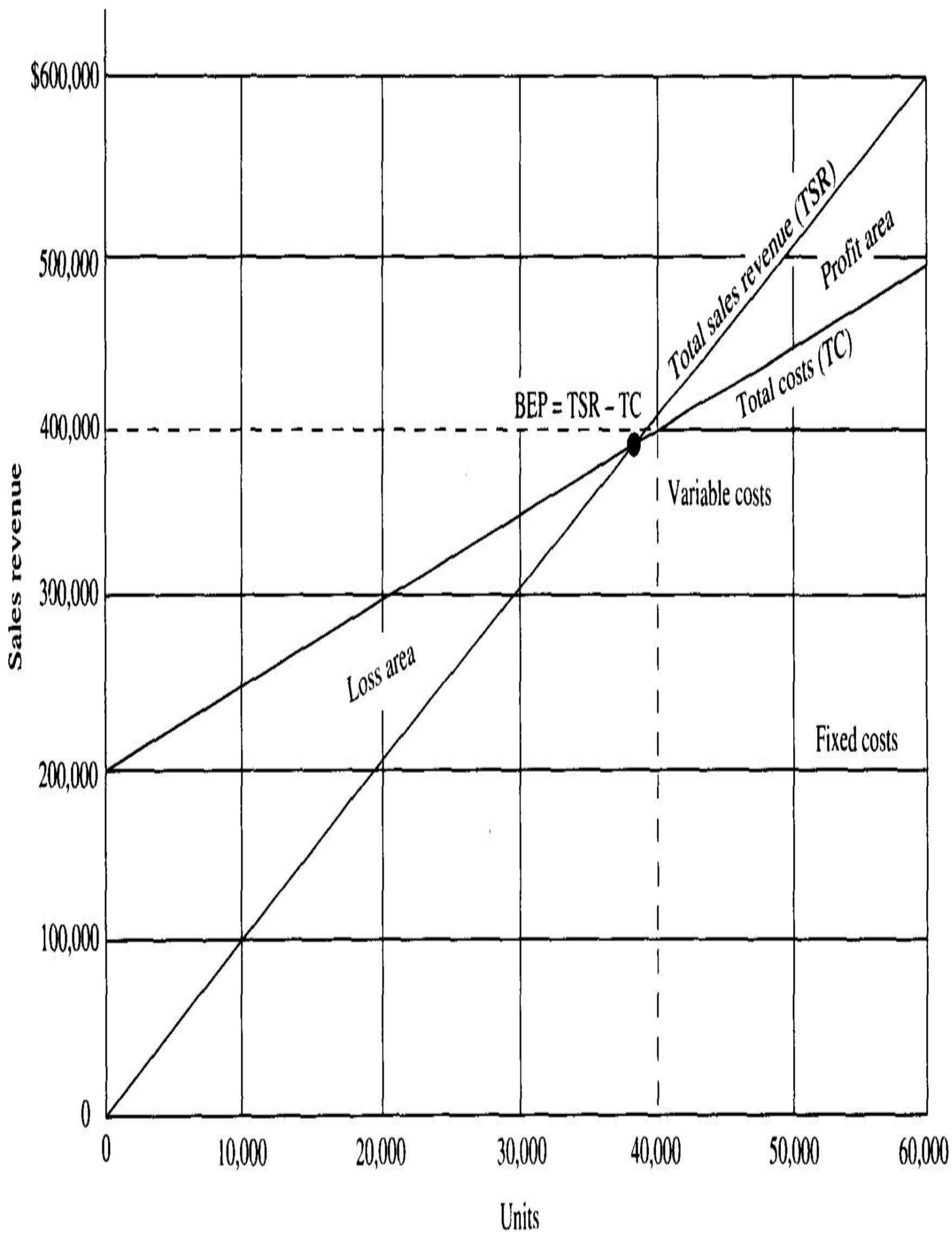


Fig. 9-3

9.4 BreakEven Point in Units. Given the following data:

Price of product	\$6	100%
Variable costs	<u>4</u>	<u>67%</u>
Contribution margin	<u>\$2</u>	<u>33%</u>
Total fixed costs	\$500	

determine the breakeven point in *units* by (a) the contribution-margin method and (b) the equation method.

SOLUTION

(a)
$$\frac{FC}{CM \text{ per unit}} = \frac{\$500}{\$2} = 250 \text{ units}$$

(b)
$$\begin{aligned} \text{Sales} &= \text{VC} + \text{FC} + \text{Profit} \\ \$6x &= \$4x + \$500 + 0 \\ \$2x &= \$500 \\ x &= 250 \text{ units} \end{aligned}$$

9.5 Cost-Volume-Profit Analysis. Assume the following data for the Forster Corporation:

	Per Unit
Sale price	\$25.00
Variable cost	18.75
Total fixed costs	\$1,250
Tax rate	40%

How many units must be sold to (a) break even, (b) attain a profit before taxes of \$1,000, (c) attain a profit after taxes of \$12,000?

SOLUTION

(a)
$$\begin{aligned} \text{Sales} &= \text{Variable costs} + \text{Fixed costs} + \text{Profit} \\ \$25x &= \$18.75x + \$1,250 + 0 \\ x &= 200 \text{ units} \end{aligned}$$

(b)
$$\begin{aligned} \frac{\text{Target profit} + \text{Total fixed costs}}{\text{Selling price per unit} - \text{Variable costs per unit}} &= \text{Sales} \\ \frac{\$1,000 + \$1,250}{\$25 - \$18.75} &= 360 \text{ units} \end{aligned}$$

(c)
$$\begin{aligned} \frac{\text{Target after-tax profit}}{(1 - T)} + \text{Total fixed cost} &= \text{Sales} \\ \frac{\$12,000}{(1 - 40\%)} + \$1,250 &= \text{Sales} \\ \frac{\$12,000}{\$25 - \$18.75} &= 3,400 \text{ units} \end{aligned}$$

Chapter 10

Capital Budgeting

10.1 CAPITAL BUDGETS

Capital expenditures involve the long-term commitments of a firm's resources.

The capital budget, which is generally prepared for a 1-year period, is the key to controlling capital expenditures. Long-range capital budgets can also be prepared for periods of 5 to 10 years and are used to plan for future expenditures. The capital budget is an efficient means of consolidating requests for funds, comparing the consolidated budget with funds made available by management, and ranking projects in order of priority.

10.2 METHODS OF EVALUATION

Quantitative methods have been developed to evaluate proposed projects. The six principal methods of evaluation are (1) payback, (2) accounting rate of return, (3) internal rate of return, (4) net present value, (5) index of profitability, and (6) discounted payback.

10.3 PAYBACK METHOD

The payback method determines the length of time it takes a project to recover its initial investment. If the annual cash flows are constant,

$$\text{Payback period } (P) = \frac{\text{Investment } (I)}{\text{Annual cash flow from operations } (C)}$$

or

$$P = \frac{I}{C}$$

Cash flow from operations is equal to net income after taxes plus depreciation.

The project with the shortest payback period would be favored. This method has several advantages: (1) it is simple to compute, (2) it is easy to understand, and (3) it is superior to the rule-of-thumb method. Among its disadvantages are that it ignores the time value of money and profitability beyond the payback period.

EXAMPLE 1

A firm is considering purchasing a machine costing \$50,000. Its useful life is estimated to be 10 years. Straight-line depreciation will be taken assuming no salvage value. The expected income is \$10,000 per year before depreciation and taxes. Assuming a 40% tax rate, the payback period is

computed as follows:

$$P = \frac{I}{C}$$

Income before depreciation and taxes	\$10,000
Less: Depreciation (\$50,000 ÷ 10 years)	<u>5,000</u>
Income before taxes	\$ 5,000
Less: Income taxes (40%)	<u>2,000</u>
Net income	3,000
Plus: Depreciation	<u>5,000</u>
Annual cash flow from operations	<u><u>\$ 8,000</u></u>

Payback period = $\frac{\$50,000}{\$8,000} = 6.25$ years

10.4 ACCOUNTING RATE OF RETURN

The accounting rate of return is computed by dividing net income by the original investment.

The project with the highest rate of return would be favored. Among the advantages of this method are that it considers income over the life of the project and is simple to compute. Among its disadvantages are that it ignores the time value of money and is not applicable if any investment is made after the project begins.

EXAMPLE 2

A \$50,000 project is expected to result in net income of \$10,000 per year for 10 years. The accounting rate of return is computed as follows:

$$\text{Accounting rate of return} = \frac{\text{Net income}}{\text{Original investment}} = \frac{\$10,000}{\$50,000} = 20\%$$

10.5 INTERNAL-RATE-OF-RETURN METHOD (IRR)

The IRR for an investment is the discount (interest) rate that will make the present (or discounted) value of the cash flow from operations equal to the initial outlay for an investment.

An IRR above the minimum rate of return specified by management (called the *hurdle rate*) is considered acceptable. When mutually exclusive projects are being compared, the project with the highest IRR will be preferred.

Among the advantages of the IRR are (1) that it recognizes the time value of money, (2) that it recognizes income over the whole life of the project, and (3) that it is expressed as a percentage return, thereby allowing a sound basis for ranking. Its major disadvantage is that it implies that earnings are reinvested at the internal rate of return, which may not be the prevailing interest rate for that type of investment.

To find the IRR of a project, one of two tables is used, depending on whether the yearly cash flows from a project are equal or not. The tables appear at the end of this chapter. [Table 10-1](#), Present Value of \$1, is used when the cash flow varies from year to year; [Table 10-2](#), Present Value

of \$1 Received Annually for N Years, is used when yearly cash flows are equal.

Table 10-1 Present Value of \$1

Years												
N	5%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%	25%
1	0.952	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	0.820	0.806	0.800
2	0.907	0.890	0.857	0.826	0.797	0.769	0.743	0.718	0.694	0.672	0.650	0.640
3	0.864	0.840	0.794	0.751	0.712	0.675	0.641	0.609	0.579	0.551	0.524	0.512
4	0.823	0.792	0.735	0.683	0.636	0.592	0.552	0.516	0.482	0.451	0.423	0.410
5	0.784	0.747	0.681	0.621	0.567	0.519	0.476	0.437	0.402	0.370	0.341	0.328
6	0.746	0.705	0.630	0.564	0.507	0.456	0.410	0.370	0.335	0.303	0.275	0.262
7	0.711	0.665	0.583	0.513	0.452	0.400	0.354	0.314	0.279	0.249	0.222	0.210
8	0.677	0.627	0.540	0.467	0.404	0.351	0.305	0.266	0.233	0.204	0.179	0.168
9	0.645	0.592	0.500	0.424	0.361	0.308	0.263	0.225	0.194	0.167	0.144	0.134
10	0.614	0.558	0.463	0.386	0.322	0.270	0.227	0.191	0.162	0.137	0.116	0.107
11	0.585	0.527	0.429	0.350	0.287	0.237	0.195	0.162	0.135	0.112	0.094	0.086
12	0.557	0.497	0.397	0.319	0.257	0.208	0.168	0.137	0.112	0.092	0.076	0.069
13	0.530	0.469	0.368	0.290	0.229	0.182	0.145	0.116	0.093	0.075	0.061	0.055
14	0.505	0.442	0.340	0.263	0.205	0.160	0.125	0.099	0.078	0.062	0.049	0.044
15	0.481	0.417	0.315	0.239	0.183	0.140	0.108	0.084	0.065	0.051	0.040	0.035
16	0.458	0.394	0.292	0.218	0.163	0.123	0.093	0.071	0.054	0.042	0.032	0.028
17	0.436	0.371	0.270	0.198	0.146	0.108	0.080	0.060	0.045	0.034	0.026	0.023
18	0.416	0.350	0.250	0.180	0.130	0.095	0.069	0.051	0.038	0.028	0.021	0.018
19	0.396	0.331	0.232	0.164	0.116	0.083	0.060	0.043	0.031	0.023	0.017	0.014
20	0.377	0.312	0.215	0.149	0.104	0.073	0.051	0.037	0.026	0.019	0.014	0.012

Table 10-2 Present Value of \$1 Received Annually for N Years

Years

<i>N</i>	5%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%	25%
1	0.952	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	0.820	0.806	0.800
2	1.859	1.833	1.783	1.736	1.690	1.647	1.605	1.566	1.528	1.492	1.457	1.440
3	2.723	2.673	2.577	2.487	2.402	2.322	2.246	2.174	2.106	2.042	1.981	1.952
4	3.546	3.465	3.312	3.169	3.037	2.914	2.798	2.690	2.589	2.494	2.404	2.362
5	4.330	4.212	3.993	3.791	3.605	3.433	3.274	3.127	2.991	2.864	2.745	2.689
6	5.076	4.917	4.623	4.355	4.111	3.889	3.685	3.498	3.326	3.167	3.020	2.951
7	5.786	5.582	5.206	4.868	4.564	4.288	4.039	3.812	3.605	3.416	3.242	3.161
8	6.463	6.210	5.747	5.335	4.968	4.639	4.344	4.078	3.837	3.619	3.421	3.329
9	7.108	6.802	6.247	5.759	5.328	4.946	4.607	4.303	4.031	3.786	3.566	3.463
10	7.722	7.360	6.710	6.145	5.650	5.216	4.833	4.494	4.192	3.923	3.682	3.571
11	8.306	7.887	7.139	6.495	5.937	5.453	5.029	4.656	4.327	4.035	3.776	3.656
12	8.863	8.384	7.536	6.814	6.194	5.660	5.197	4.793	4.439	4.127	3.851	3.725
13	9.394	8.853	7.904	7.103	6.424	5.842	5.342	4.910	4.533	4.203	3.912	3.780
14	9.899	9.295	8.244	7.367	6.628	6.002	5.468	5.008	4.611	4.265	3.962	3.824
15	10.380	9.712	8.559	7.606	6.811	6.142	5.575	5.092	4.675	4.315	4.001	3.859
16	10.838	10.106	8.851	7.824	6.974	6.265	5.669	5.162	4.730	4.357	4.033	3.887
17	11.274	10.477	9.122	8.022	7.120	6.373	5.749	5.222	4.775	4.391	4.059	3.910
18	11.690	10.828	9.372	8.201	7.250	6.467	5.818	5.273	4.812	4.419	4.080	3.928
19	12.085	11.158	9.604	8.365	7.366	6.550	5.877	5.316	4.844	4.442	4.097	3.942
20	12.462	11.470	9.818	8.514	7.469	6.623	5.929	5.353	4.870	4.460	4.110	3.954

Case 1. If cash flows are conventional (equal cash flows for each year of the project), the IRR can be computed by using the following technique:

$$\text{IRR annuity factor} = \frac{\text{Initial investment}}{\text{Annual cash flow}}$$

The resulting annuity factor is converted into the IRR by looking up the annuity factor on a table showing the present value (PV) of \$1 received annually over a period of years (Table 10-2). Limit your search for the IRR annuity factor to the row of the table that represents the number of years the project is expected to last. Move along that row until the IRR annuity factor (or the amount closest to it) is found. The interest rate appearing at the top of that column is the IRR for the project.

EXAMPLE 3

A project under consideration requires an initial investment of \$54,000 and is expected to result in a cash flow from operations equal to \$15,000 per year for 7 years.

The IRR is computed as follows:

$$\text{IRR annuity factor} = \frac{\text{Initial investment}}{\text{Annual cash flow}} = \frac{\$54,000}{\$15,000} = 3.6$$

To convert the annuity factor into the IRR, Table 10-2 is used. Since the duration of the project is 7 years, the row designated as year 7 is searched for the nearest value to 3.6. An annuity factor of 3.605 is listed in this row under the 20% column. The IRR is therefore 20%.

Case 2. When the cash flow from operations is not equal each year, the computation to determine the IRR is more complex and involves trial-and-error procedures. Table 10-1, Present Value of \$1, is used instead of Table 10-2 because the cash flow varies from year to year and therefore the present value of each year's cash flow must be independently computed.

EXAMPLE 4

Assume an initial outlay of \$32,318 and that the cash flow from operations is as follows:

Year	Cash Flow from Operations
1	\$ 8,000
2	8,000
3	10,000
4	16,000

The objective is to find the discount rate that will make the present value of the cash flow from operations equal to the initial outlay.

If we start with 12%, the results are as follows:

Year	Cash Flow from Operations	×	12% Discount Rate PV of \$1 (Table 10-1)	=	Present Value
1	\$ 8,000		0.893		\$ 7,144
2	8,000		0.797		6,376
3	10,000		0.712		7,120
4	16,000		0.636		10,176
					<u><u>\$30,816</u></u>

The total present value is \$30,816, but since this is not equal to the \$32,318 initial outlay, 12% is not the IRR. The lower the discount rate used, the higher the present value: therefore, in our next attempt to find IRR, we will use a lower discount rate in order to get a higher present value.

At 10% the following results:

Year	Cash Flow from Operations	×	10% Discount Rate PV of \$1 (Table 10-1)	=	Present Value
1	\$ 8,000		0.909		\$ 7,272
2	8,000		0.826		6,608
3	10,000		0.751		7,510
4	16,000		0.683		10,928
					<u><u>\$32,318</u></u>

The IRR is 10% because at this discount rate, the cash flow from operations is equal to the initial outlay.

Sometimes an IRR falls between two values of a given table (for example, suppose the IRR calculated above was somewhere between 10 and 12 percent). In that case either a more detailed present value table is consulted or an approximation method based on interpolation is used to arrive at the IRR.

10.6 NET-PRESENT-VALUE METHOD (NPV)

To calculate the NPV, the cash flow from operations is discounted at the required minimum rate of

return (hurdle rate) and the initial outlay is then deducted. If the discounted cash flow is greater than the initial outlay (i.e., the NPV is positive), the project is profitable and therefore acceptable.

The primary advantages of the NPV are (1) that the NPV can always be calculated (unlike the IRR), (2) that it considers the time value of money, and (3) that it recognizes income over the whole life of the project.

EXAMPLE 5

The initial outlay for a project is \$40,000. It is expected to generate \$10,000 per year as cash flow from operations for the next 10 years. Assuming a hurdle rate of 16%, the NPV is computed as follows.

From [Table 10-2](#) the present value of \$1 received annually for 10 years at 16% is found to be 4.833. So the cash flow discounted at the hurdle rate is

$$4.833 \times \$10,000 = \$48,330$$

Then the net present value is

$$\begin{aligned} \text{NPV} &= \text{Cash flow discounted at hurdle rate} - \text{Initial investment} \\ &= \$48,330 - \$40,000 = \$8,330 \end{aligned}$$

Since the NPV is positive, the project is profitable and therefore acceptable.

10.7 INDEX OF PROFITABILITY METHOD (IP)

The IP, also called the profitability index or the benefit-cost ratio, is found by dividing the present value of the cash flow from operations by the initial outlay. The IP must be greater than 1 for a project to be considered attractive.

EXAMPLE 6

From the information given in [Example 5](#) the IP is computed as follows:

$$\frac{\text{PV of cash flow } (4.833 \times \$10,000)}{\text{Initial outlay}} = \frac{\$48,330}{\$40,000} = 1.20825$$

This project is acceptable.

10.8 DISCOUNTED-PAYBACK METHOD

The discounted-payback method restates the payback method by taking the time value of money into consideration. The annual cash flow from operations is discounted at the required rate of return before the payback period is computed.

EXAMPLE 7

Assume that a project costing \$20,000 is expected to return \$7,000 per year for the next 10 years and that the firm's required rate of return is 14%. The discounted payback period is computed as

follows:

Year	Cash Flow from Operations	Present Value of \$1 at 14% (Table 10.1)	Present Value	Discounted Payback Period (Years)
1	\$7,000.00	0.877	\$ 6,139	1.00
2	7,000.00	0.769	5,383	1.00
3	7,000.00	0.675	4,725	1.00
4	6,339.53*	0.592	3,753†	0.91‡
			<u>\$20,000</u>	<u>3.91</u>

* $\$3,753 \div 0.592 = \$6,339.53$.

† $\$20,000 - (\$6,139 + \$5,383 + \$4,725) = \$3,753$.

‡ $\$6,339.53 \div \$7,000 = 0.906 \approx 0.91$.

10.9 REPLACEMENT CHAINS

Replacement chains are established only for mutually exclusive projects (competing projects that do the same job) with different lives. By definition, the adoption of one mutually exclusive project results in the immediate rejection of the others. However, when project lives differ, conflicts may arise over which project to adopt because the IRR and NPV have different implicit assumptions for the reinvestment of the cash flow from operations. The replacement chain is simply a technique that repeats the cash flows of one project until both projects have equal lives. Once the replacement chains have been developed, the adjusted cash flows are used for computing the IRR and NPV of each project. This is done only to make a comparison possible; a more precise determination of profitability would require an investigation of how each project would actually be continued beyond its projected life.

EXAMPLE 8

Assume two mutually exclusive projects have cash flows from operations as follows:

End of Year	Project A	Project B
0 (initial outlay)	\$ - 5,000	\$ - 5,000
1	+ 3,000	+ 2,000
2	+ 5,500	+ 2,500
3		+ 3,000
4		+ 2,500

A replacement chain for project A is set up that simply repeats the initial outlay and cash flow from operations, starting at the end of year 2.

End of Year	Project A (Original)	Replacement Chain	Project A (Assuming Replacement)
0	\$ - 5,000	—	\$ - 5,000
1	+ 3,000	—	+ 3,000
2	+ 5,500	\$ - 5,000	+ 500
3	—	+ 3,000	+ 3,000
4	—	+ 5,500	+ 5,500

Had project B lasted 3 years instead of 4, a common-denominator year would be chosen (in this example, 6 years), and a replacement chain would be constructed for both projects based on 6 years.

10.10 COMPUTATION OF CASH FLOW FROM OPERATIONS

Cash flow from operations is the net income after taxes expected to be generated from a project plus depreciation.

For purposes of analysis the following adjustments to cash flow from operations may be necessary:

- (1) When mutually exclusive projects with different lives are analyzed, the cash flows must be adjusted by using replacement chains.
- (2) If an investment is expected to have a salvage value, the salvage value is considered a lumpsum payment to be received at the end of the investment. The estimated salvage value must therefore be discounted to its present value and treated as an addition to cash flow from operations.
- (3) If additional working capital is needed for a project and is expected to be recouped at the end of the project, the working capital is considered as an initial outlay. The working capital which is expected to be recouped is considered a lumpsum payment to be received at the end of the investment. The estimated working capital expected at the end of the investment must therefore be discounted to its present value and treated as an addition to cash flow from operations.

Solved Problems

10.1 Payback and Accounting Rate of Return. The Arnold Manufacturing Company is considering the purchase of a new machine. Its cost is \$30,000; its expected useful life is 10 years (assume no salvage value); and it will be depreciated on a straight-line basis. Income before depreciation and taxes is expected to be \$15,000. Assuming a 40% tax rate, compute the (a) payback period and (b) the accounting rate of return.

SOLUTION

(a) Payback Period

$$P = \frac{I}{C}$$

Income before depreciation and taxes	\$15,000
Less: Depreciation (\$30,000 ÷ 10 years)	<u>3,000</u>
Income before taxes	\$12,000
Less: Income taxes (40%)	<u>4,800</u>
Net income	7,200
Add: Depreciation	<u>3,000</u>
Annual cash flow from operations	<u><u>\$10,200</u></u>

$$\text{Payback period} = \frac{\$30,000}{\$10,200} = 2.94 \text{ years}$$

(b) Accounting Rate of Return

$$\frac{\text{Net income}}{\text{Original investment}} = \frac{\$7,200}{\$30,000} = 24\%$$

10.2 The Internal Rate of Return. S. Vollmer Co. is considering a project that requires an initial investment of \$79,800. It is expected to result in a cash flow from operations of \$35,000 per year for 3 years. Compute the internal rate of return.

SOLUTION

$$\frac{\$79,800}{\$35,000} = 2.28 \text{ IRR annuity factor} \approx 16\% \text{ IRR}$$

Because the cash flow is conventional, [Table 10.2](#) is used to convert the annuity factor into the IRR as follows. The value closest to 2.28 in the row for 3 years (the life of the project) is 2.246, which is in the 16% column. Hence the IRR is approximately 16%.

10.3 Net Present Value. A. Gee is thinking about a project that needs an initial outlay of \$54,000. It is expected to return \$12,000 per year as cash flow from operations for the next 9 years. The company's hurdle rate is 16%. Using the NPV method, determine whether the project should be accepted or rejected.

SOLUTION

4.607 [PV of \$1 received annually (Table 10.2) at 16% for 9 years] × \$12,000	\$55,284
Less: Initial outlay	<u>54,000</u>
Net present value	<u><u>\$ 1,284</u></u>

Since the NPV is positive, the project should be accepted.

10.4 Index of Profitability. The JGH Manufacturing Company is considering the purchase of a new machine. The present value of the cash flow from operations is \$37,650. The machine requires an initial outlay of \$32,000.

(a) Compute the index of profitability and (b) determine whether you would invest in the new machine.

SOLUTION

$$(a) \quad \text{Index of profitability} = \frac{\text{Present value of cash flows}}{\text{Initial outlay}} = \frac{\$37,650}{\$32,000} = 1.177$$

(b) Yes, the investment should be considered because the IP is greater than 1.

10.5 Discounted Payback Method. The Hoffman Corporation bought a new machine costing \$25,000 and which is expected to generate cash flows from operations of \$10,000 per year for the next 5 years. The firm's required rate of return is 12%. Compute the discounted payback period.

SOLUTION

Year	Cash Flow from Operations	Present Value of \$1 at 12% (Table 10-1)	Present Value	Discounted Payback Period (Years)
1	\$10,000.00	0.893	\$ 8,930	1.00
2	10,000.00	0.797	7,970	1.00
3	10,000.00	0.712	7,120	1.00
4	1,540.88*	0.636	980†	0.15‡
			<u>\$25,000</u>	<u>3.15</u>

* $\$980 \div 0.636 = \$1,540.88$.

† $\$25,000 - (\$8,930 + \$7,970 + \$7,120) = \$980$.

‡ $\$1,540.88 \div \$10,000 = 0.15$.

Chapter 11

Relevant Costing in Decision Making and Performance Measurement

Relevant Costing in Decision Making

11.1 INTRODUCTION

Management is often required to make critical decisions. Should a new product line be added or an old product line deleted? Should a special order be accepted or rejected? Should component parts or raw materials be produced or purchased? Should old machinery be kept or replaced? It is the cost accountant's responsibility to summarize all relevant data that will serve as the basis for making the decision. This section of the chapter concerns itself with costs relevant to decision analyses.

11.2 RELEVANT VS. IRRELEVANT COSTS

Relevant costs are expected future costs that differ among alternatives. They are directly affected by management's actions. Irrelevant costs, on the other hand, are unaffected by the decision. Relevancy is not an attribute of a particular cost; the identical cost may be relevant in one circumstance and irrelevant in another.

EXAMPLE 1

A college student graduating this year is deciding whether to take a job immediately or enter graduate school. The costs relevant to continuing her education are tuition, fees, books, and supplies. Room, board, and clothing costs are irrelevant since they will be incurred regardless of her decision. Also important to her decision is the potential salary she would forego while attending school. If she decides to attend graduate school, this particular relevant cost would be considered an opportunity cost. (See [Section 11.5](#) for a more detailed discussion of opportunity costs.)

11.3 DIFFERENTIAL OR INCREMENTAL COSTS

Differential, or incremental, costs are those costs which differ from the base cost incurred by all alternatives. As such, differential costs are composed of only that portion of the total cost which is specifically incurred by an alternative. Such costs are relevant when they differ from the alternatives being considered.

When analyzing a special decision, the key is the differential effects of each option on the company's profits. Frequently, variable costs and incremental costs are the same. However, should an additional batch or special order extend production beyond the relevant range, both variable and

total fixed costs would increase. In that event, the differential fixed costs should be included in the analysis.

EXAMPLE 2

Stephen is driving from New York City to Houston, Texas and would like some companionship on the trip. He asks his friend Sarah to accompany him. Stephen asks Sarah to pay for only the incremental costs of the trip. The trip expenses are as follows:

Gasoline	\$ 80.00
Tolls	10.00
Motel rooms (\$30 for each single room)	60.00
Sarah's meals	28.00
Stephen's meals	<u>23.00</u>
Total trip expenses	<u><u>\$201.00</u></u>

Sarah's incremental costs for the trip would be \$58.00. This includes the \$30 charge for her motel room and the \$28 for her meals. Stephen will incur all the other expenses even if he travels alone.

The adjective "relevant" denotes the pertinence of a cost to the evaluation process, whereas "differential" denotes how that relevance is determined. Furthermore, not all differential costs need be relevant, since the latter depend on the situation. So, if Stephen were trying to determine whether to ask Laura or Sarah to accompany him on the trip, the incremental costs would be irrelevant since they would be the same for both.

11.4 SUNK COSTS

In managerial accounting, historical costs are frequently referred to as *sunk costs*. Sunk costs are past committed costs that are now irrevocable. They are not relevant to future decisions and should not be considered in an analysis, except for possible tax effects upon their disposition and lessons to be learned from the past decisions.

EXAMPLE 3

Ellis Industries, a computer manufacturer, has in its inventory \$80,000 worth of disk-drive housings for a computer line that is now obsolete. The housings can be remachined to fit a newer line at a cost of \$15,000 and then sold for \$33,000. Ellis Industries' other alternative is to sell the housings as scrap for \$12,000.

Decision

	(1)	(2)	(1) – (2)
	Remachine	Scrap	Incremental Effect
Revenues	\$33,000	\$12,000	\$21,000
Additional costs	<u>15,000</u>	<u>-0-</u>	<u>15,000</u>
Net profit	<u><u>\$18,000</u></u>	<u><u>\$12,000</u></u>	<u><u>\$ 6,000</u></u>

The \$80,000 inventory cost is an irrelevant sunk cost and is therefore not considered in that analysis. The only relevant factors are the future revenues and the future costs. By choosing to remachine the housings instead of scrapping them, Ellis Industries can increase its profits—or decrease its losses—by \$6,000.

11.5 OPPORTUNITY COSTS

When a decision to pursue one alternative is made, the benefits of the other options are foregone. Benefits lost from rejecting the second-best option are the *opportunity costs* of the chosen action.

Since opportunity costs are not actually incurred, they are not recorded in the accounting records. They are, however, relevant costs for decision making and should be considered in evaluating a proposed alternative.

The real value of opportunity costs is often difficult to determine since other factors impinge. For example, a decision by management to minimize carrying costs by keeping inventory levels low may result in stock shortages. The sales lost become the opportunity cost of this decision. The level of inventory that will profitably minimize *both* carrying costs and possibility of stock shortages would then have to be determined.

In determining opportunity costs, one should be certain that the costs are derived from viable alternatives. For example, lost rent is an opportunity cost only if there are potential tenants willing to rent the facilities at a determined price.

EXAMPLE 4

Jim Martin owns a men's clothing store in Philadelphia. He was recently offered the position of store manager at Anthony's, a large retail chain store in the area. Working at Anthony's, Jim would earn an annual salary of \$50,000. Jim knows that he could sell the net assets of his business for \$115,000 but is uncertain whether to sell the business and manage Anthony's or continue operating his own store. Jim begins his analysis of the two alternatives by examining his store's income statement from last year:

Revenue from sales		\$225,000
Cost of goods sold		<u>135,000</u>
Gross profit		\$ 90,000
<i>Operating expenses</i>		
Rent	\$ 7,200	
Employee wages	17,000	
Utilities	3,640	
Supplies	560	
Advertising	1,450	
Professional fees	1,150	
Insurance	820	
Miscellaneous	<u>630</u>	
Total operating expenses		<u>32,450</u>
Net income		<u><u>\$ 57,550</u></u>

Jim's analysis should not stop here. He must now subtract from his net income the two opportunity costs involved in the decision:

- (1) The salary he would forego if he continues to operate his own clothing store.
- (2) The interest income he would receive from investing the proceeds from the sale of his business.

Further analysis considering opportunity costs is as follows:

Net income (from income statement)		\$ 57,550
Less: Opportunity costs		
Foregone salary	\$50,000	
Foregone interest income at assumed 17% interest rate (\$115,000 × 17%)	<u>19,550</u>	
Total opportunity costs		<u>69,550</u>
Loss of income from failure to accept the offer		<u><u>\$(12,000)</u></u>

Had he ignored the opportunity costs, Jim Martin might have erroneously concluded that it would be more profitable to stay with his store, since his present income is \$7,550 above the salary offered by Anthony's. However, after studying the opportunity costs involved, Jim knows that he would be losing \$12,000 in the first year by keeping his business.

This analysis is purely quantitative, and Jim Martin must also measure the qualitative factors, such as loss of independence in being self-employed compared with the \$12,000 loss in income.

11.6 SEGMENTAL ANALYSIS

In the process of segmenting a company by departments, product lines, divisions, types of customers, etc., management can analyze specific areas of the firm to determine whether they should be continued, expanded, or dropped.

In the event that a segment is dropped, the impact on that segment's total costs depends on the nature of the costs involved. The segment's variable costs will disappear if the segment is dropped, but the total fixed costs may or may not be affected. Fixed costs can be classified as *separable costs* and *joint costs*. A separable fixed cost exists only because the segment exists; it will be eliminated if the segment is discontinued. Joint costs, however, remain after the disposal and must be absorbed by the remaining segments. Variable costs are always separable and are eliminated when the segment is eliminated.

11.7 DISCONTINUING A SEGMENT

Quantitatively, a segment should be dropped if by doing so the reduction in costs exceeds the revenue

lost. The qualitative factors include the impact of discontinuing the segment on the rest of the business and management's ability to use resources in an alternative manner. Often the elimination of a product line causes the sales of other lines to decrease. Both the qualitative and quantitative elements must be measured before arriving at a decision to drop a segment.

The following example pertains to segmenting by product line. The same format could be followed for evaluating other types of segmenting, such as by divisions or services provided. Generally, the incremental approach (Sec. 11.2) is used to determine whether a segment should be dropped.

EXAMPLE 5

Jennings, Inc., a manufacturer of hair-care products, is considering dropping from its line a finishing rinse, which is presently losing money. The following information concerns Jennings' three products:

	Shampoo	Finishing Rinse	Conditioner	Total
Sales revenue	\$500,000	\$300,000	\$400,000	\$1,200,000
Variable costs	<u>270,000</u>	<u>202,000</u>	<u>220,000</u>	<u>692,000</u>
Contribution margin	<u>\$230,000</u>	<u>\$ 98,000</u>	<u>\$180,000</u>	<u>\$ 508,000</u>
<i>Fixed Costs</i>				
Separable	\$ 56,000	\$ 59,000	\$ 45,000	\$ 160,000
Joint*	<u>100,000</u>	<u>60,000</u>	<u>80,000</u>	<u>240,000</u>
Total	<u>\$156,000</u>	<u>\$119,000</u>	<u>\$125,000</u>	<u>\$ 400,000</u>
Profit (loss)	<u><u>\$ 74,000</u></u>	<u><u>\$(21,000)</u></u>	<u><u>\$ 55,000</u></u>	<u><u>\$ 108,000</u></u>

* Allocated on the basis of total sales dollars.

From the above, it appears that by dropping the finishing rinse line. Jennings, Inc. would save \$21,000 a year. However, incremental analysis leads to quite a different conclusion:

Finishing Rinse
Incremental Analysis of Dropping Line

Variable costs avoided	\$202,000	
Separable fixed costs avoided	<u>59,000</u>	
Total costs avoided		\$261,000
Decrease in revenue		<u>(300,000)</u>
Increase (decrease) in net income		<u><u>\$ (39,000)</u></u>

In actuality, a \$39,000 decrease in total company income (\$18,000 more than the \$21,000 loss from keeping the line) would result if the finishing rinse line were dropped. The revenue of the product covers both the variable costs and the separable fixed costs, therefore helping to cover the joint costs and to provide income. Jennings, Inc. should discontinue the line only if the opportunity cost of using the space and resources in another way exceeds the incremental profit of the present course of action.

Another method of evaluating this problem is by constructing an income statement based on the assumption that the line is dropped:

	Shampoo	Conditioner	Total
Sales revenue	\$500,000	\$400,000	\$900,000
Variable costs	<u>270,000</u>	<u>220,000</u>	<u>490,000</u>
Contribution margin	<u>\$230,000</u>	<u>\$180,000</u>	<u>\$410,000</u>
<i>Fixed costs</i>			
Separable	\$ 56,000	\$ 45,000	\$101,000
Joint*	<u>133,333</u>	<u>106,667</u>	<u>240,000</u>
Total	<u>\$189,333</u>	<u>\$151,667</u>	<u>\$341,000</u>
Profit (loss)	<u><u>\$ 40,667</u></u>	<u><u>\$ 28,333</u></u>	<u><u>\$ 69,000</u></u>

* Allocated on the basis of total sales dollars.

The same result, a decrease of \$39,000 (\$108,000 – \$69,000) in total company net income, is arrived at whichever method is used.

It should also be noted that eliminating the finishing rinse line may have a considerable effect on the sales of the other hair products. A consumer may stop buying the shampoo and conditioner if the rinse is not available and may switch to a competitor's products if the competitor provides the entire product line.

11.8 SELL OR PROCESS FURTHER

Joint products are the result of a single production process that yields two or more products. Joint products are frequently found in industries that process raw materials. Examples include the chemical, petroleum, and wood industries, as well as producers of cattle or dairy products. In the cattle industry, products such as various cuts of meat, leather from hide, and sundries from bones are obtained from the cattle.

If external markets exist for these semifinished products, the manufacturer must decide which products are more profitable to sell at the split-off point and which ones should be processed further before sale. The *split-off point* is that point where the separate products emerge from the joint

process. Products emerging from the process that are not salable at any point are simply discarded.

The costs incurred before split-off are irrelevant in determining whether or not the products should be processed further. They need to be considered only in determining whether the entire process should be undertaken at all.

Incremental analysis provides the basis for solving this problem. Generally, if the additional revenue earned by processing further is greater than the additional cost, the product should be processed further; however, if the converse is true, the product should be sold at the split-off point.

EXAMPLE 6

P. M. Meyer operates a tree farm on the West Coast. The cost of felling, transporting, and initial processing of the trees is \$12,000 per section of trees. Tree trunks are trimmed to remove bark and to square off the log so that it can be cut into planking. Mr. Meyer is currently selling the tree products at the split-off point, but is considering processing them further. Sales values and costs needed to evaluate Meyer's production policy are as follows:

Costs and Revenues per Section of Trees						
		(1)	(2)	(3)	(4)	(5)
	Product If		Sales Revenue		Additional	Incremental
Product at	Processed	Sales Revenue	If Processed	Incremental	Processing	Contribution
Split-Off	Further	at Split-Off	Further	Revenue*	Costs	of Further
						Processing**
Bark	Particle board	\$ 1,000	\$ 1,500	\$ 500	\$ 800	\$ (300)
Trimmed pieces	Plywood	6,500	8,400	1,900	1,700	200
Trimmed log	Planking	15,600	21,000	5,400	4,200	1,200

* Revenue if processed further - Revenue at split-off.

** Incremental revenue - Additional processing costs.

For this analysis, the \$12,000 initial processing cost is an irrelevant cost. The decision of whether to process further can be made by examining column 5. Meyer should keep selling the bark at the split-off point, since processing it further would decrease the firm's profits by \$300. However, the

other products of the joint process should be processed further since this would increase company profits by \$1,400 ($\$1,200 + \200) per section of trees.

11.9 SPECIAL ORDERS—ACCEPT OR REJECT

Manufacturers often produce goods under both their brand name and a chain store's name. The products sold to chains are usually modified slightly and sold at lower prices than the products bearing the manufacturer's name. In addition to producing and selling on a regular basis, sometimes a firm is in a position to accept a special one-time order for its products at below normal price. In the short run, a firm can occasionally increase total profit by accepting orders at prices that exceed the differential costs. Differential costs of an order usually are composed of only variable costs, although not all variable costs are always relevant to the decision. For example, sales commissions are variable costs but usually are not paid on a special order and therefore would not be relevant to the decision.

For a special order, fixed costs generally are not considered because they are fully absorbed by the normal output. The only time fixed costs are considered relevant and should be considered in the analysis is when the fixed costs are expected to change currently or in the future because of the specific decision to accept the additional business. If the special order increases the activity level to the point of requiring additional supervision, plant, equipment, insurance, and/or property taxes, those fixed costs are relevant.

Generally, a special order should be accepted if:

- (1) The incremental revenue exceeds the incremental cost of the order.
- (2) The facilities used are idle and have no other, more profitable use.
- (3) The order does not disrupt the market for the firm's regular output.

Emphasis should be placed on the effects a special order will have on the firm's future sales at regular prices (requirement 3 above). Prospective customers may take advantage of products being offered at reduced prices by the special-order customer instead of buying the firm's product, or existing customers may become irritated by the firm's policy and discontinue their purchases.

EXAMPLE 7

Snowshoe, Inc., a manufacturer of ski equipment, has been asked to sell 1,000 pairs of skis to a discount sporting goods shop in Maine for \$100 a pair. Snowshoe would not put its name on this special order, and the dealer would therefore sell the skis below their normal retail price. The capacity for Snowshoe is 25,000 pairs of skis per year. The company's sales forecast for this year, excluding the special order, is 20,000 pairs at a selling price of \$143.75 per unit. Snowshoe's budgeted income statement is:

Budgeted Income Statement

	Per Unit	Total
Sales revenue (20,000 pairs)	<u>\$143.75</u>	\$2,875,000
<i>Cost of goods sold</i>		
Direct materials	\$ 37.50	\$750,000
Direct labor	31.10	622,000
Factory overhead (40% variable)	<u>34.45</u>	<u>689,000</u>
Total	<u>\$103.05</u>	<u>2,061,000</u>
Gross profit	\$ 40.70	\$ 814,000
Selling and administrative expenses	<u>27.50</u>	<u>550,000</u>
Net income	<u><u>\$ 13.20</u></u>	<u><u>\$ 264,000</u></u>

The only variable portion of the selling and administrative expenses is a 12% commission on sales, which would not be paid on the special order. Should Snowshoe accept the special order at \$100 a pair even though the average cost to produce and sell a pair of skis is \$130.55 (\$103.05 + \$27.50)

Incremental Analysis of the Special Order

	Per Unit	Total
Sales revenue (1,000 pairs)	<u>\$100.00</u>	\$100,000
<i>Manufacturing costs</i>		
Direct materials	\$ 37.50	\$37,500
Direct labor	31.10	31,100
Variable overhead (40% × \$34.45)	<u>13.78</u>	<u>13,780</u>
Total	<u>\$ 82.38</u>	<u>82,380</u>
Incremental profit	<u><u>\$ 17.62</u></u>	<u><u>\$ 17,620</u></u>

Snowshoe, Inc. would increase its profits by \$17,620 if it accepts the special order. It would therefore be advantageous to do so.

11.10 MAKE-OR-BUY DECISIONS

When idle equipment, space, or labor exists, management is presented with the choice of internally producing parts rather than purchasing them. This choice is known as the *make-or-buy decision*. Frequently, the manufactured components can be produced at lower incremental costs than those charged by external suppliers. If a firm can produce as economically as potential suppliers, it can save the profit a supplier would normally earn.

In order to properly evaluate a make-or-buy decision, both the quantity and quality standards of the component must be the same for both alternatives. Then, to determine the cost to buy, the total cost of bringing the product in the same condition and to the same location as if internally manufactured must be considered—not just the purchase price. Examples of additional costs to be included in the buy option are transportation, incoming inspection, insurance, and ordering costs. The costs of the make alternative include the incremental manufacturing costs, such as direct labor, direct materials, and variable overhead. Allocated fixed costs that remain unchanged in total when the parts are manufactured are irrelevant to make-or-buy decisions. They will be incurred regardless of whether the component is bought or made. If an additional capital investment is made, however, the costs and the timing of the cash flows must be accounted for.

Another quantitative consideration to be examined is the possibility of alternative uses for the idle

capacity. New products could be manufactured instead of component parts, and the contribution margin from these products would be considered the opportunity costs of making the components. Alternatively, if unused equipment or space were leased or rented, the net profit would then be regarded as the opportunity cost of the make decision.

EXAMPLE 8

Pratt Industries is considering making its own motor castings, which it currently purchases for \$20.50 per unit. This purchase price does not include the ordering, receiving, and inspection costs, which Pratt estimates to be \$2 per unit. Pratt feels that it can manufacture the 6,500 required units at a lower cost than it pays by purchasing externally. The relevant costs for both the producing and buying alternatives are as follows:

Incremental Analysis for Motor Castings (6,500 Units)

	Per Unit	Cost to Make	Cost to Buy
Direct materials	\$ 6.25	\$ 40,625	
Direct labor	10.00	65,000	
Variable factory overhead	5.00	32,500	
Purchase price	20.50		\$133,250
Ordering, receiving, and inspection costs	2.00		13,000
Total relevant costs		\$138,125	\$146,250

Assuming that Pratt's facilities will remain idle if they do not manufacture the casting, Pratt Industries would increase income by \$8,125 per year (\$146,250 – \$138,125) by making the component instead of purchasing it. If, however, Pratt could use the idle capacity to manufacture a new product line instead of producing the motor castings, the contribution margin of the new product line must be considered as an opportunity cost of the “make” decision. The estimated revenue and cost data for the housings (new product line) are as follows:

	Per Unit	Total
Sales revenue (4,800 units)	<u>\$31.25</u>	<u>\$150,000</u>
<i>Manufacturing costs</i>		
Direct materials	10.00	\$48,000
Direct labor	12.25	58,800
Variable overhead	<u>5.00</u>	<u>24,000</u>
Total	<u>\$27.25</u>	<u>130,800</u>
Incremental profit	<u><u>\$ 4.00</u></u>	<u><u>\$ 19,200</u></u>

Decision

	(1)	(2)	(1) - (2)
	Make	Buy	Incremental Effect
Total cost of purchasing motor castings	-0-	\$146,250	\$(146,250)
Incremental cost of manufacturing motor castings	\$138,125	-0-	138,125
Opportunity cost of manufacturing housings	<u>19,200</u>	<u>-0-</u>	<u>19,200</u>
Net relevant costs	<u><u>\$157,325</u></u>	<u><u>\$146,250</u></u>	<u><u>\$ 11,075</u></u>

The firm would benefit by \$11,075 if it elects to buy the motor castings and manufacture the housings.

11.11 PRODUCT MIX DECISION

When a company manufactures more than one item, the optimum combination to produce must be determined. The following procedure is followed when making this decision:

- (1) Produce the maximum of the item with the highest contribution margin per unit under a particular constraint (e.g., machine hours).
- (2) If there are any remaining machine hours, produce the maximum that can be sold of the item with the next highest contribution margin per unit, continuing until all machine hours are utilized.

EXAMPLE 9

A company produces three products and expects to sell 5,000 units of each. The maximum capacity is 40,000 machine hours. Per unit data for each product are:

	A	B	C
Sales price	\$25	\$50	\$40
Variable costs	10	30	18
Contribution margin	15	20	22
Machine hours required	4	5	1

Since product C has the highest contribution margin per unit, this should be produced first, followed by product B and then product A.

Total available machine hours	40,000
Less: Product C machine hours (1 hour × 5,000)	<u>5,000</u>
Balance	35,000
Less: Product B machine hours (5 hours × 5,000)	<u>25,000</u>
Balance available for product A	10,000
Divide by: Machine hours for product A	<u>4</u>
Production of product A	<u><u>2,500</u></u>

Performance Measurement

11.12 APPROACHES TO PERFORMANCE MEASUREMENT

After the company divisions have been established and the related authorities and responsibilities assigned, it is vital that an adequate system be developed for measuring the performance of both the divisions and the division managers.

There are many approaches to an evaluation program. Their selection depends on the needs of the enterprise and the wishes of management. For example, should performance be gauged in terms of net income, net sales, or net income in relation to investment? Should income after income taxes or income before income taxes be used? Should the basis of measurement for the divisions be the same as that for the company as a whole? No one answer will suit the needs of all companies. However, one of the most common methods of performance measurement in use is the *return on investment* (ROI).

11.13 RETURN ON INVESTMENT (ROI)

The return-on-investment or return-on-capital method has been used for many years by banks to measure the performance of borrowers. The rate of return on investment for the total company is usually computed by dividing net income by total assets. Total assets may be referred to as investment, invested capital, capital employed, *etc.* (the terms are often used interchangeably).

The ROI method has many important advantages over most other methods. It is simple to compute and can be used to measure and compare divisional or company performance, returns on competing companies, returns on competing capital projects, and many other factors, thereby permitting management to select the most favorable option from alternatives.

EXAMPLE 10

The ROI method and its advantage over the return-on-sales method are illustrated in the following comparison of companies X and Y:

	Company X	Company Y
Sales	\$2,000,000	\$2,000,000
Net income	300,000	300,000
Return on sales	15%	15%
Investment	\$3,000,000	\$1,500,000
Return on investment	10%	20%

Both companies have the same sales volume, the same net income, and the same return on sales. However, to earn that income, Company X is using \$3,000,000 in assets, twice as much as Company Y. Thus Company X is earning only 10% on assets employed while Company Y is earning 20% on assets employed.

11.14 RETURN-ON-INVESTMENT RATIO

A simple way to express the return on investment is by an equation. The ROI equation is generally shown in two parts, the *investment turnover* and the *earnings ratio*. The investment turnover is stated as:

$$\text{Investment turnover} = \frac{\text{Sales}}{\text{Total assets}}$$

The earnings ratio shows the sales-expense relationship and is stated as:

$$\text{Earnings ratio} = \frac{\text{Net income}}{\text{Sales}}$$

Investment turnover indicates management's efficiency in using available assets to generate sales volume and earnings. The earnings ratio indicates the percentage of profit in each dollar of sales. The **ROI** equation is made up of both the above components:

$$\text{ROI} = \text{Investment turnover} \times \text{Earnings ratio}$$

Upon superficial examination, it appears that the equation could be simplified by canceling out sales in the two components. If this were done, however, the independence of the two separate variables, investment turnover and earnings ratio, would be lost.

11.15 ADVANTAGES AND DISADVANTAGES OF ROI

The advantages of this method are that ROI can

- (1) Act as a comprehensive measure, sensitive to every influence affecting the financial status of a company.
- (2) Focus management's attention upon maximizing earnings on invested capital (total assets employed).
- (3) Serve as a basis for measuring management's performance in utilizing total assets as well as divisional resources.
- (4) Help make the goals of the division manager coincide with those of corporate management.
- (5) Provide a means for objective comparison of various internal performance results among divisions and with projected external performance results.
- (6) Help division managers evaluate and improve their own performance.
- (7) Provide an incentive to use existing assets to their full extent, thereby limiting the acquisition of additional resources to those which will increase the return on investment ratio.

The disadvantages of the ROI method are that

- (1) It focuses on maximizing a ratio rather than improving absolute profit amounts.
- (2) The established rate of return may be too high and could discourage divisional incentive.
- (3) A division manager may be reluctant to acquire additional investments that might lower the ROI.
- (4) Division managers may make decisions which help raise the divisional ROI ratio but which are not good for the long-term interest of the company.

11.16 TOTAL COMPANY EVALUATION

Total company evaluation is often used when one company wishes to compare its return on investment with that of another company. This is an *external evaluation* rather than the *internal evaluation* done in measuring divisional performance. Total data for most companies can generally be obtained from such published reports as the annual report to stockholders or to the Securities and Exchange Commission. Generally, only final results such as net sales and net income are needed, and the invested capital is the total assets used in the business. There are differences of opinion over which figures should be included for some of the factors of the equation. For example, should net income be used, or would it be better to use operating income so that nonoperating expense and income are deleted? Care must be exercised in making comparisons between companies when further data are lacking. Such comparisons may be distorted if, for example, entirely different products or divisions are included in the totals.

EXAMPLE 11

Company B is considering the acquisition of Company Y, a small company in the same kind of business. Company B wishes to earn at least 16% on the Company Y investment, the same as it earns on its own invested capital. Given the following data for Company Y,

Sales	\$ 60,000
Investment required	\$100,000
Earnings ratio	20%

the return on investment is calculated as follows:

$$\begin{aligned} \text{ROI} &= \text{Investment turnover} \times \text{Earnings ratio} = \frac{\text{Sales}}{\text{Total assets}} \times \text{Earnings ratio} \\ &= \frac{\$60,000}{\$100,000} \times 20\% = 0.60 \times 20\% = 12\% \end{aligned}$$

Because of the low investment turnover of 0.60, or 60%, the resulting ROI is only 12%, well below the required 16%, therefore the investment would not be undertaken.

11.17 DIVISIONAL EVALUATION

The ROI concept has proven to be very effective for internal evaluation in many large industrial companies. In order for a company to obtain maximum results from decentralization, constant monitoring of divisional operations is essential. In the past, central management was mostly concerned with dollar sales, dollar earnings, and profit margins. Generally, the operating income figure is used in comparing divisional results. Nonoperating expense and income would generally be maintained on the headquarters books. The divisional ROI equation is usually stated as:

$$\text{ROI} = \frac{\text{Divisional sales}}{\text{Divisional total assets}} \times \frac{\text{Divisional operating income}}{\text{Divisional sales}}$$

or

$$\text{ROI} = \text{Divisional investment turnover} \times \text{Divisional earnings ratio}$$

EXAMPLE 12

The Adams Company wants to compare the ROIs of two of its divisions, the Venice Division and the Englewood Division. The pertinent information is as follows:

<u>Division</u>	<u>Sales</u>	<u>Operating Income</u>	<u>Total Assets</u>
Venice	\$1,200,000	\$135,000	\$950,000
Englewood	475,000	75,000	550,000

The ROI for each division is calculated as follows:

$$\text{Venice ROI} = \frac{\$1,200,000}{\$950,000} \times \frac{\$135,000}{\$1,200,000} = 1.26 \times 11.3\% = 14.2\%$$

$$\text{Englewood ROI} = \frac{\$475,000}{\$550,000} \times \frac{\$75,000}{\$475,000} = 0.86 \times 15.8\% = 13.6\%$$

We can see the significance of individual computations for investment turnover and earnings ratio. The Venice Division turned over its investment 1.26 times, while Englewood turned over its investment only 0.86 time. However, the earnings ratio, or percentage, was just the reverse. Venice earned only 11.3% on sales, while Englewood earned 15.8%. The net result shows that Venice had an ROI of 14.2% and Englewood had an ROI of 13.6%.

11.18 RESIDUAL INCOME

One of the stated shortcomings of ROI is its emphasis on *rate* of return rather than on absolute dollars. To overcome this, some companies use a target rate or *imputed-interest rate*, and the excess of net income above this figure is considered the *residual income*. The formula is

$$\text{Residual income} = \text{Net income} - (\text{Investment} \times \text{Imputed-interest rate})$$

An important advantage of this method is that a particular division may expand as long as it earns a rate in excess of the charge for invested capital (imputed interest). Under this method, managers generally concentrate on increasing dollars rather than improving only the ROI percentage rate.

EXAMPLE 13

The Fred Williams Company used the residual-income method in performance measurement of its divisional operations. The following are the results for the past year for Division A:

Division A

Invested capital (Total assets)	\$100,000	
Net income		\$18,000
Return on investment	18%	
Investment charge at 12% imputed- interest rate ($\$100,000 \times 12\%$)		<u>12,000</u>
Residual income		<u><u>\$ 6,000</u></u>

Division A earned \$18,000, or 18%, on the assets the company had invested in that division. If it had had to borrow those funds outside, the company would have had to pay 12%. Therefore, the division is expected to earn in excess of 12% and can expand as long as it can generate such a residual income.

Solved Problems

11.1 Discontinuing a Segment. The management of Franco Corporation is concerned about Department B, which showed a loss of \$1,300 last quarter. You have been asked to prepare an analysis that will help management decide whether to discontinue the department. Below is Franco's income statement for last quarter.

	Department A	Department B	Total
Sales revenue	\$260,000	\$130,000	\$390,000
Variable costs	<u>156,000</u>	<u>117,000</u>	<u>273,000</u>
Contribution margin	<u>\$104,000</u>	<u>\$ 13,000</u>	<u>\$117,000</u>
<i>Fixed costs</i>			
Separable	\$ 11,300	\$ 5,700	\$ 17,000
Joint	<u>17,400</u>	<u>8,600</u>	<u>26,000</u>
Total	<u>\$ 28,700</u>	<u>\$ 14,300</u>	<u>\$ 43,000</u>
Profit (loss)	<u><u>\$ 75,300</u></u>	<u><u>\$ (1,300)</u></u>	<u><u>\$ 74,000</u></u>

Showing all calculations, determine the effect of closing Department B on Franco Corporation and make a recommendation.

SOLUTION

Incremental Analysis of Discontinuing Department B

Benefits

Variable costs avoided	\$117,000	
Separable fixed costs avoided	<u>5,700</u>	
Total		\$ 122,700

Losses

Decrease in revenues		<u>\$(130,000)</u>
Increase (decrease) in net income		<u><u>\$ (7,300)</u></u>

Franco Corporation should continue operating Department B, because dropping it would decrease the corporation's income by \$7,300 (almost 6 times as much as the current operating loss of \$1,300).

11.2 Sell or Process Further. Mead Industries produces three products from a joint process. Each product can be sold at the split-off point or processed further. From the data given below, determine for management which products should be sold at split-off and which should be processed further.

Product	Sales Revenue at Split-Off	Additional Processing Costs	Sales Revenue If Processed Further
1	\$37,500	\$13,500	\$63,000
2	61,500	10,500	67,500
3	36,000	12,000	50,000

SOLUTION

Product	Incremental Revenue*	Incremental Contribution of Further Processing**
1	\$25,500	\$12,000
2	6,000	(4,500)
3	14,000	2,000

* Revenue if processed further – Revenue at split-off.

** Incremental revenue – Additional processing costs.

Mead Industries should sell product 2 at split-off and process products 1 and 3 further.

11.3 Special Orders. Howard Industries produces a single product in large quantities. The company is currently operating at 60% of capacity and wishes to increase its production level. Howard is considering accepting a government contract for next year for 15,000 units at \$3.60 per unit. The company's normal selling price is \$5.25, and its annual capacity is 60,000 units. The fixed costs are \$30,000, and the variable costs are \$2.80 per unit. The company does not pay sales commissions.

Assuming that the government contract would not create any market retaliation, should Howard Industries accept it? (Support your answer with computations.)

SOLUTION

	Units
Current production (60% × 60,000 unit capacity)	36,000
Government requirement	<u>15,000</u>
Total	<u><u>51,000</u></u>

Incremental Analysis

	Per Unit	Total
Sales (15,000 units)	\$3.60	\$54,000
Variable manufacturing costs	<u>2.80</u>	<u>42,000</u>
Incremental profit	<u><u>\$0.80</u></u>	<u><u>\$12,000</u></u>

Assuming that sales do not increase by more than 9,000 units (60,000 – 51,000) next year, Howard Industries would have the necessary capacity to produce the units required by the government contract. The company should, therefore, accept the contract, which will increase profit by \$12,000.

11.4 Make-or-Buy Decisions and Opportunity Costs. J. W. Haines Corporation annually produces 10,000 units of assembly part number 206. An outside supplier has offered to manufacture the part for Haines at \$19 per part. If Haines decides to buy the part, they will be able to rent the existing area for \$8,000 a year. Listed below are Haines' total costs to produce part 206.

	Per Unit	Total
Direct materials	\$ 2.50	\$ 25,000
Direct labor	14.00	140,000
Variable overhead	2.25	22,500
Fixed overhead	<u>0.75</u>	<u>7,500</u>
Total costs	<u><u>\$19.50</u></u>	<u><u>\$195,000</u></u>

Assuming that no additional costs are incurred in purchasing the part, should Haines make or buy? Support your answer with computations.

SOLUTION

	Make	Buy
Purchase price ($\$19 \times 10,000$ units)		\$190,000
Incremental cost to make [($\$2.50 + \$14 + \$2.25$) $\times 10,000$ units]	\$187,500	
Opportunity cost—Rent	<u>8,000</u>	<u> </u>
Net relevant costs	<u><u>\$195,500</u></u>	<u><u>\$190,000</u></u>

J. W. Haines Corporation would save \$5,500 ($\$195,500 - \$190,000$) by purchasing assembly part 206 and renting the facilities.

11.5 Performance Measurement. Santoro Corporation has two divisions, A and B. Total sales for the year were \$1,200,000. It is estimated that Division B will account for 60% of the total sales. Santoro wishes to earn 14% on its investment. Compute (a) investment turnover, (b) earnings ratio, (c) return on investment, and (d) residual income for each division from the following data:

	Division A	Division B
Cost of goods sold	\$300,000	\$500,000
Selling and administrative expenses	150,000	150,000
Plant investment	200,000	300,000

SOLUTION

	Division A	Division B
Sales	\$480,000 (40%)	\$720,000 (60%)
Cost of goods sold	<u>300,000</u>	<u>500,000</u>
Gross profit	\$180,000	\$220,000
Selling and administrative expenses	<u>150,000</u>	<u>150,000</u>
Net income	<u><u>\$ 30,000</u></u>	<u><u>\$ 70,000</u></u>

(a)

$$\text{Investment turnover} = \frac{\text{Sales}}{\text{Plant investment}}$$

Division A: $\frac{\$480,000}{\$200,000} = 2.40$ or 240% Division B: $\frac{\$720,000}{\$300,000} = 2.40$ or 240%

(b)

$$\text{Earnings ratio} = \frac{\text{Net income}}{\text{Sales}}$$

Division A: $\frac{\$30,000}{\$480,000} = 6.25\%$ Division B: $\frac{\$70,000}{\$720,000} = 9.72\%$

(c)

$$\text{ROI} = \text{Investment turnover} \times \text{Earnings ratio}$$

Division A: $240\% \times 6.25\% = 15\%$ Division B: $240\% \times 9.72\% = 23\%$

(d) Residual income = Net income – (Investment × Imputed-interest rate)

	Department A	Department B
Net income	\$30,000	\$70,000
Investment charge* (14%)	<u>28,000**</u>	<u>42,000***</u>
Residual income	<u>\$ 2,000</u>	<u>\$28,000</u>

* Investment charge = Investment \times Imputed-interest rate.

** \$200,000 \times 14% = 28,000.

*** \$300,000 \times 14% = \$42,000.

11.6 ROI— Divisional Income. Hennessey Corporation must close one of its divisions. From the following data determine which division should be kept open on the basis of ROI and residual income. The company wants to earn 18% on its investment.

	Division A	Division B
Net income	\$160,000	\$225,000
Investment turnover	80%	90%
Earnings ratio	20%	25%

SOLUTION

$$\text{ROI} = \text{Investment turnover} \times \text{Earnings ratio}$$

$$\text{Division A: ROI} = 80\% \times 20\% = 16\%$$

$$\text{Division B: ROI} = 90\% \times 25\% = 22.5\%$$

$$\text{Residual income} = \text{Net Income} - \text{Investment charge}$$

	Division A	Division B
Net income	\$160,000	\$225,000
Investment charge (18%)*	<u>180,000</u>	<u>180,000</u>
Residual income (loss)	<u><u>\$ (20,000)</u></u>	<u><u>\$ 45,000</u></u>

* *Calculation:*

$$\text{ROI} = \frac{\text{Sales}}{\text{Investment}} \times \frac{\text{Net income}}{\text{Sales}}$$

Division A:

$$\text{Investment} = \frac{\text{Net income}}{\text{ROI}} = \frac{\$160,000}{16\%} = \$1,000,000$$

$$\begin{aligned} \text{Investment charge} &= \$1,000,000 \times 18\% \text{ imputed-interest rate} \\ &= \$180,000 \end{aligned}$$

Division B:

$$\text{Investment} = \frac{\$225,000}{22.5\%} = \$1,000,000$$

$$\text{Investment charge} = \$1,000,000 \times 18\% = \$180,000$$

The Hennessey Corporation should keep Division B open.

Chapter 12

Decision Theory and Economic Order Quantity

Decision Theory

12.1 AN OUTLINE OF THE DECISION-THEORY METHOD

Decision theory is an area of statistics used when data are uncertain or incomplete. Decision theory evaluates different courses of action open to a manager when those courses can be measured monetarily.

Usually, the decision-theory method is stated mathematically. The following elements are generally used in developing a decision-theory model.

Quantifiable Objective. A specified goal that can be measured; particularly, that function whose monetary value management wants to maximize or minimize (for example, profit or cost).

Decision Variables or Actions. Alternatives available to the decision maker. They must be defined and mutually exclusive.

Payoff. The monetary reward or consequence for each decision variable or action.

Uncontrollable Variables or Events. States of nature that are uncontrollable in the decision-theory model. They must be completely defined and mutually exclusive.

Probabilities. The likelihood of the occurrence of each event.

12.2 GENERAL APPROACH TO UNCERTAINTY

The general approach to dealing with uncertainty is to (1) delineate possible events (E) and actions (A) for the problem, (2) estimate the probability of occurrence of each event, and (3) determine which event is most likely to yield the greatest profit.

EXAMPLE 1

A small store sells fresh relish at \$2 per jar. It costs the proprietors \$1.25 per jar. If the relish is not sold by the end of the month, it spoils and the proprietors take a loss on the unsold jars. The proprietors believe that they can estimate the demand and make the following predictions:

Demand (Jars)	Probability of Event $P(E)$
E_1 0	0.10
E_2 1	0.60
E_3 2	0.30

Thus, the possible actions of the proprietors are:

A_1 = Order no relish

A_2 = Order 1 jar of relish

A_3 = Order 2 jars of relish

These data can be analyzed by formulating the following payoff table: **Payoff**

		A_1 : Order 0		A_2 : Order 1		A_3 : Order 2	
Demand (Events)	$P(E)$	Actual	Expected	Actual	Expected	Actual	Expected
		Profit	Profit*	Profit	Profit*	Profit	Profit*
E_1	0.10	0	0	\$-1.25	\$-0.125	\$-2.50	\$-0.25
E_2	0.60	0	0	0.75	0.45	-0.50	-0.30
E_3	0.30	0	0	0.75	<u>0.225</u>	1.50	<u>0.45</u>
Expected profit for each action†			<u>0</u>		<u>\$ 0.55</u>		<u>\$-0.10</u>

* Expected profit = Actual profit \times Probability of events $P(E)$.

† Expected profit for each action = Σ expected profit for E_1, E_2, E_3 .

Based on the results of the payoff table, the optimal strategy under uncertainty is to order 1 jar of relish since this yields the highest expected payoff (a profit of \$0.55).

EXAMPLE 2

Suppose the proprietors knew exactly how many jars of relish to order. For example, if they knew the demand for that month would be exactly 1 jar, they would order only one jar. With this idea in mind, the expected value of having such perfect information would be calculated as follows:

Demand (Jars)	$P(E)$	Actual Profit	Expected Profit*
0	0.10	0	0
1	0.60	\$0.75	\$0.45
2	0.30	1.50	<u>0.45</u>
Expected value of profit under perfect information			<u><u>\$0.90</u></u>

* Expected profit = Probability \times Actual profit.

If we subtract the optimal expected value of profit under uncertainty (\$0.55) from the expected value of the profit under perfect information (\$0.90), we have computed the expected value of perfect information (EVPI).

Expected value of profit under perfect information	\$0.90
Expected value of profit under uncertainty	<u>0.55</u>
EVPI	<u><u>\$0.35</u></u>

EVPI is the highest price one should pay for having perfect demand information.

12.3 PROJECT PROPOSALS AND UNCERTAINTY

To evaluate competing projects the process is basically the same, except that cash flows constitute possible events and the following formula is used to compute the expected value of each project:

$$\bar{X} = \sum_{i=1}^n X_i P_i$$

where \bar{X} = Expected value of all cash flows Σ = Sum of

X_i = Individual cash flows

P_i = Probabilities assigned to each cash flow

n and i specify the conditions of the summation, so that for $\sum_{i=1}^n$ we proceed from 1 on up to the n th

$$\sum_{i=1}^n X_i P_i = X_1 P_1 + X_2 P_2 + X_3 P_3 + \dots + X_n P_n$$

$$\bar{X} = \sum_{i=1}^n X_i P_i$$

degree:

EXAMPLE 3

Company D is considering two projects, each having a one-year “use” period.

Project I		Project II	
Probability	Cash Flow	Probability	Cash Flow
0.25	\$4,000	0.10	\$ 0
0.50	5,000	0.50	3,000
0.25	8,000	0.40	10,000

To determine which project to choose, the manager of the company decided to compute the expected value of each project. The project with the highest expected value would then be chosen.

$$\text{Project I } (X_1): \bar{X}_1 = [0.25(\$4,000) + 0.50(\$5,000) + 0.25(\$8,000)] = \$5,500$$

$$\text{Project II } (X_2): \bar{X}_2 = [0.10(0) + 0.50(\$3,000) + 0.40(\$10,000)] = \$5,500$$

Since each project has the same expected value (\$5,500), this computation of the expected value will not help the manager choose one project over the other. In a situation of this sort, the standard deviation of each project is computed to determine the risk involved. The standard deviation

describes the dispersion of the probabilities assigned to the events $S = \sqrt{\sum_{i=1}^n (X_i - \bar{X})^2 P_i}$

where X_i = Individual cash flows

\bar{X} = Expected value of all cash flows P_i = Probabilities assigned to each cash flow

EXAMPLE 4

The computation of the standard deviation for each project follows.

Project I (S_1):

$$\begin{aligned} S_1 &= \sqrt{0.25(4,000 - 5,500)^2 + 0.50(5,000 - 5,500)^2 + 0.25(8,000 - 5,500)^2} \\ &= \sqrt{562,500 + 125,000 + 1,562,500} = \sqrt{2,250,000} \\ &= 1,500 \end{aligned}$$

Project II (S_2):

$$\begin{aligned} S_2 &= \sqrt{0.10(0 - 5,500)^2 + 0.50(3,000 - 5,500)^2 + 0.40(10,000 - 5,500)^2} \\ &= \sqrt{3,025,000 + 3,125,000 + 8,100,000} = \sqrt{14,250,000} \\ &= 3,774.92 \end{aligned}$$

The project with the *lowest* standard deviation involves the *least* risk. Project I would be less risky and is therefore preferred.

The standard deviation is a relative measure of uncertainty when expected values are equal. If the expected values are *not* equal, the standard deviation is not an appropriate measure of risk. The appropriate measure of risk or uncertainty in this circumstance would be the *coefficient of variation*:

$$\text{Coefficient of variation} = \frac{\text{Standard deviation of project}}{\text{Expected value of project}}$$

The *higher* the coefficient of variation, the *greater* the risk.

12.4 PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT) AND UNCERTAINTY

PERT is a tool used for management planning and control and involves the theory of the critical-path method (CPM). PERT can be used to minimize production delays, to schedule research and development, and to help complete projects on time.

The following terms are used with PERT:

Activity. One step in the production process necessary to complete a project.

Event. The incident or accomplishment at a specific location or stage that marks the beginning or end of an activity.

Project. Sequence of interrelated activities, each of which requires resources and a given duration in order to be completed.

The objective is to identify those activities and events which, if delayed, will cause the whole project to be delayed.

EXAMPLE 5

The following schedule depicts the activities and events necessary to produce a product.

Network

Activity	Predecessor Activity	Representation for Activity	Beginning Event	Ending Event
<i>A</i>	—	1-2	1	2
<i>B</i>	—	1-3	1	3
<i>C</i>	<i>A</i>	2-4	2	4
<i>D</i>	<i>B</i>	3-4	3	4
<i>E</i>	<i>C, D</i>	4-5	4	5

From the above data, the PERT network in Fig. 12-1 can be developed.

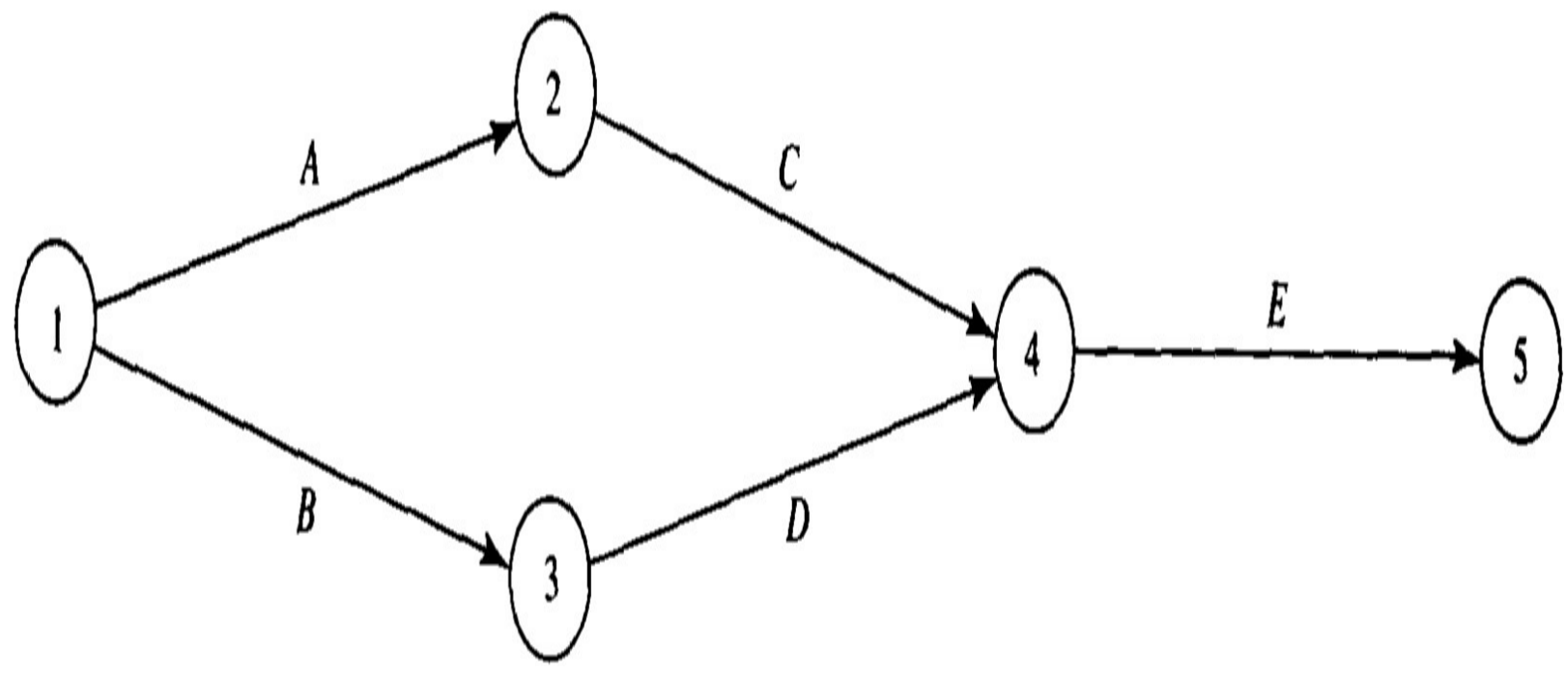


Fig. 12-1. Pert Network.

Because the duration of each activity cannot be predicted perfectly, variable time estimates are used. They are determined by beta distribution as follows:

- a* = Optimistic estimate (shortest time)
- m* = Most likely estimate
- b* = Pessimistic estimate (longest time)

The estimated time t_e for each activity is then calculated by using the algebraic formula:

$$t_e = \frac{a + 4m + b}{6}$$

EXAMPLE 6

Given the following values for a , m , and b , the t_e for each activity depicted in the PERT network (Fig. 12-1) is as follows:

Activity	Time (Calendar Weeks)			
	a	m	b	$t_e = \frac{a + 4m + b}{6}$
A	2	3	4	3
B	5	8	11	8
C	2	4	6	4
D	4	6	8	6
E	0.5	2	3.5	2

The critical path, the longest path through the network, can now be determined. Any delay along this path will delay production as a whole. Also, in order to shorten the total time, the critical path must be shortened.

EXAMPLE 7

The time to complete a path is the sum of the activity durations Σt_e along that path. For the

Path	Duration Σt_e (weeks)
ACE	$3 + 4 + 2 = 9$
BDE	$8 + 6 + 2 = 16$

network in Fig. 12-1 the two paths are **BDE**. The longer path, **BDE**, determines the overall duration of the production and is called the *critical path*. Another method for determining the critical path uses the following terminology: T_E = earliest expected time to complete activity

$$T_L = \text{latest expected time to complete activity before delays occur}$$
$$S = \text{slack time for activity}$$
$$= T_L - T_E$$

EXAMPLE 8

From the data given in Example 6, the critical path is calculated as follows: *Step I*: Calculate T_E by adding t_e of the predecessor activities to t_e of the current activity.

Current Activity

 t_e
 t_e (Weeks)

Activity	t_e	t_e (Weeks)
A	$0 + 3A$	3
B	$0 + 8B$	8
C	$0 + 3A + 4C$	7
D	$0 + 8B + 6D$	14
E	$0 + 8B + 6D + 2E$	16*

* The longest path to an activity is chosen.

Step 2: Calculate T_L . This requires working backward along the PERT network (Fig. 12-1) from the longest T_E (critical path) (Fig. 12-2). So the T_L for A would be

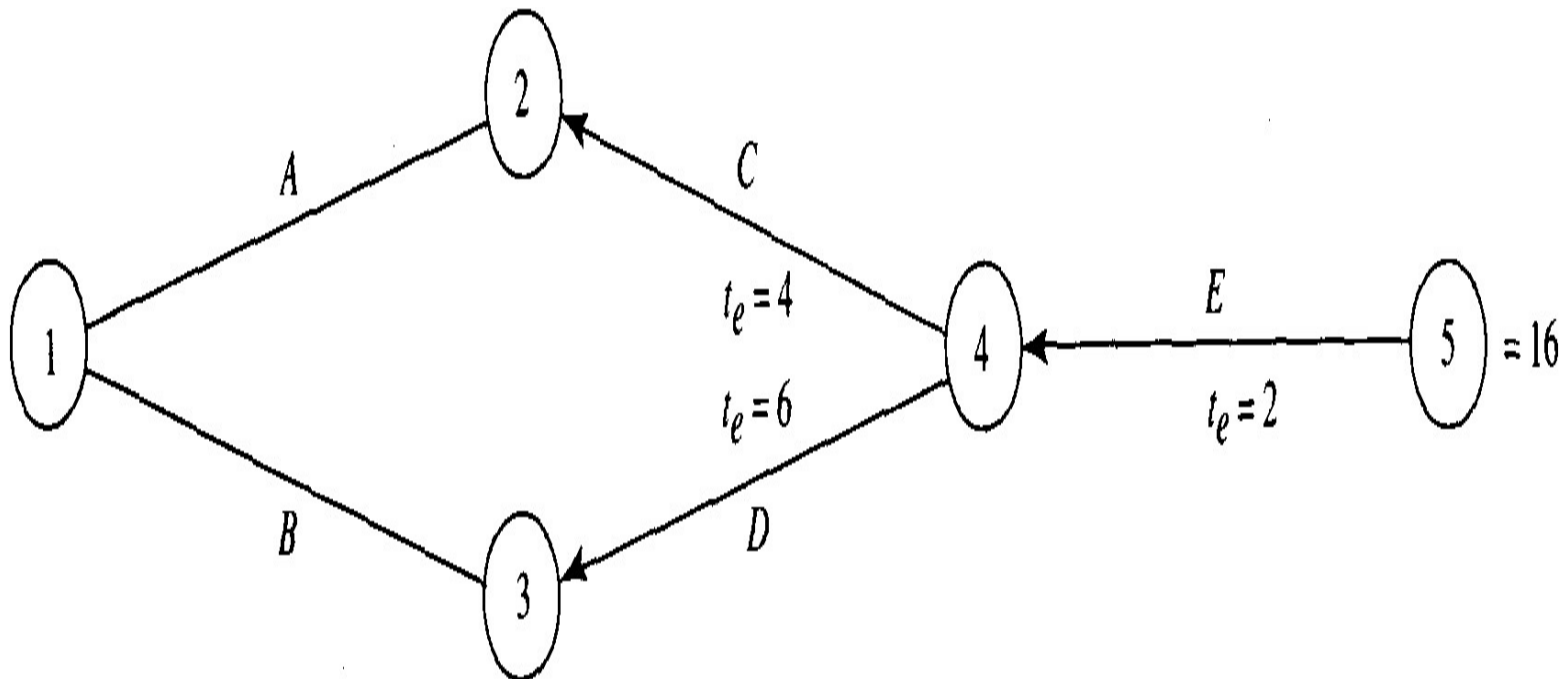


Fig. 12-2. Critical Path.

Longest $T_E = (t_{e,E} + t_{e,C})$

where $t_{e,E}$ stands for t_e of activity E, or $16 - (2 + 4) = 10$

Activity	T_L	Computation
<i>A</i>	10	$16 - (2t_{e,E} + 4t_{e,C})$
<i>B</i>	8	$16 - (2t_{e,E} + 6t_{e,D})$
<i>C</i>	14	$16 - 2t_{e,E}$
<i>D</i>	14	$16 - 2t_{e,E}$
<i>E</i>	16	$16 - 0$

Step 3: Calculate S by subtracting T_E from T_L .

Activity	T_L	T_E	$S = T_L - T_E$
<i>A</i>	10	3	7
<i>B</i>	8	8	0
<i>C</i>	14	7	7
<i>D</i>	14	14	0
<i>E</i>	16	16	0

The critical path comprises those activities with zero slack.

12.5 INVENTORY COSTS AND CONTROL—ECONOMIC ORDER QUANTITY

The control of inventories is necessary to safeguard against shortages and to provide for a continuous, even flow of production. The three costs included in the *total cost* of any inventory are (1) total ordering costs, (2) total carrying costs, and (3) total acquisition costs.

Total Ordering Costs. Those clerical and processing costs incurred in the purchase of raw materials.

Total Carrying Costs. Those costs incurred to keep an inventory of raw materials in a company's possession; for example, costs stemming from insurance, breakage, and storage space.

Total Acquisition Costs. The actual price paid to suppliers. These costs are often irrelevant when planning inventory policy, except when a discount is offered.

EXAMPLE 9

The annual materials requirement is estimated to be 1,000 units. It costs \$10 to place an order. Materials cost per unit is currently \$2. The annual carrying cost as a percent of average annual inventory value is 10%. Assuming that one order is placed annually, the total cost of inventory is as follows: *Total Annual Inventory Cost*

	Cost
Total ordering cost	\$ 10
Total carrying cost*	100
Total acquisition cost	
(1,000 units at \$2 cost per unit)	<u>2,000</u>
Total cost of inventory	<u><u>\$2,110</u></u>

* *Calculation:*

$$\frac{1,000 \text{ units}}{2 \text{ units}} = \text{Average annual inventory of 500 units}$$

$$500 \text{ units} \times \$2 \text{ cost per unit} \times 10\% = \$100$$

Note that the *average* annual number of units on hand during the year (computed by dividing the annual materials requirement by 2) is used to calculate the total carrying cost.

12.6 DETERMINATION OF ECONOMIC ORDER QUANTITY

A major aim of an inventory policy is to minimize total inventory costs. The policy must properly balance two costs (total carrying costs and total ordering costs). The order size that results in the minimum total inventory cost is called the *economic order quantity* (EOQ). The EOQ can be determined by using the tabular, graphic, or formula method.

(1) *Tabular Method.* Several purchase-order quantity alternatives are listed in separate columns. Both the carrying and ordering costs are calculated for each alternative. The column with the *lowest* cost will give a good approximation of the economic order quantity.

EXAMPLE 10

Assume the following:

Estimated annual required inventory	2,000 units
Materials cost per unit	\$2.00
Ordering cost per order	\$3.00
	Per unit per year
	\$0.20
	or as % of unit inventory
	10%

The EOQ is computed using the tabular method as follows:

	Order Size (Units)					
<i>Quantity Data</i>	100	200	225	250	275	300
Number of orders						
(annual required inventory ÷ order size)	20	10	8.9	8	7.3	6.7
Average inventory						
(order size ÷ 2)	50	100	112.5	125	137.5	150
<i>Cost Data</i>						
Annual carrying cost						
(average inventory units × \$0.20)	\$10	\$20	\$22.50	\$25	\$27.50	\$30.00
Annual ordering cost						
(number of orders × \$3)	<u>60</u>	<u>30</u>	<u>26.70</u>	<u>24</u>	<u>21.90</u>	<u>20.10</u>
Total annual inventory cost	<u><u>\$70</u></u>	<u><u>\$50</u></u>	<u><u>\$49.20</u></u>	<u><u>\$49</u></u>	<u><u>\$49.40</u></u>	<u><u>\$50.10</u></u>

The limitations of this method are evident. Since not every possible order quantity was calculated, the EOQ is not precise; it may fall between 225 and 250 units or between 250 and 275 units. Further analysis would be needed to determine the exact EOQ.

(2) **Graphic Method.** The EOQ is determined by plotting the annual ordering costs, annual carrying costs, and total inventory costs on a graph. In [Fig. 12-3](#) the horizontal axis represents the order quantity, and the vertical axis represents ordering and carrying costs.

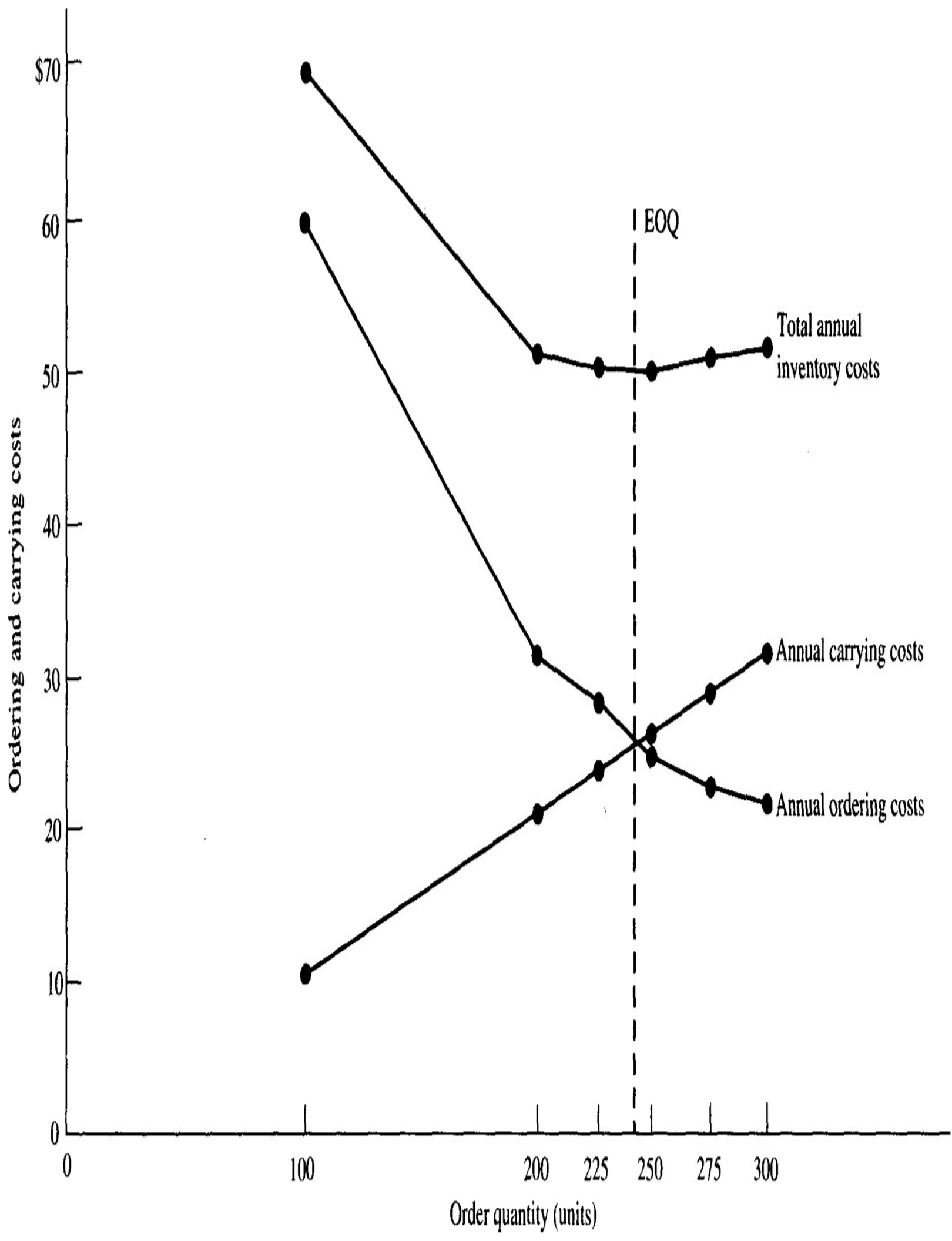


Fig. 12-3.

EXAMPLE 11

A graphic presentation of the data tabulated in [Example 10](#) is presented in [Fig. 12-3](#).

The EOQ is between 225 and 250 units since the lines representing annual ordering and carrying costs intersect at a point between these two order quantities. It is possible to determine exact units if the graph is sufficiently detailed.

(3) **Formula Method.** The following equations can be used to calculate the EOQ in *units*:

$$\text{EOQ (units)} = \sqrt{\frac{2 \times \text{RU} \times \text{CO}}{\text{CU} \times \text{CC}}} = \sqrt{\frac{2 \times \text{RU} \times \text{CO}}{S}}$$

where RU = Annual required units

CO = Ordering cost per order

CU = Materials cost per unit

CC = Carrying cost as a percentage of unit inventory value

S = Carrying cost per unit per year

The equation for EOQ in *dollars* is

$$\text{EOQ (dollars)} = \sqrt{\frac{2AB}{I}}$$

where A = Annual required inventory, dollars

B = Ordering cost per order

I = Inventory carrying costs as percentage of unit inventory value

EXAMPLE 12

The data are the same as those given for [Example 10](#).

RU = 2,000 units CU = \$2 materials cost per unit CO = \$3 per order CC = 10% carrying cost

The EOQ in units is computed as follows: $\text{EOQ (units)} = \sqrt{\frac{2 \times 2,000 \times \$3}{\$2 \times 10\%}} = \sqrt{\frac{12,000}{0.2}} = 244.95 \approx 245$

The EOQ in dollars is computed as follows:

A = 2,000 units × \$2 materials cost per unit = \$4,000

B = \$3 ordering cost per order I = 10% inventory carrying cost

$$\text{EOQ (dollars)} = \sqrt{\frac{2 \times \$4,000 \times \$3}{10\%}} = \sqrt{\frac{\$24,000}{0.10}} = \$489.90$$

12.7 INVENTORY ORDER POINT

The *order point* (when to place an order) should be at the time the inventory level reaches the number of units that would be consumed during the lead time. The *lead time* is the period between placing an order and receiving the materials. The *average inventory usage rate* is the quantity of materials used over a period of time. An equation or a graphic presentation can be used to determine

the order point. The following data will be used to illustrate both methods:

Lead time	5 weeks
Average inventory usage rate	100 units per week
EOQ	1,000 units

(1) *Equation.*

$$\text{Inventory order point} = \text{Lead time} \times \text{Average inventory usage rate}$$

EXAMPLE 13

The computation of the order point by the equation method is as follows:

Inventory order point = 5 weeks \times 100 units per week = 500 units (normal usage for 5-week period) (2) *Graphic Presentation.* The graph (Fig. 12-4) is plotted as follows:

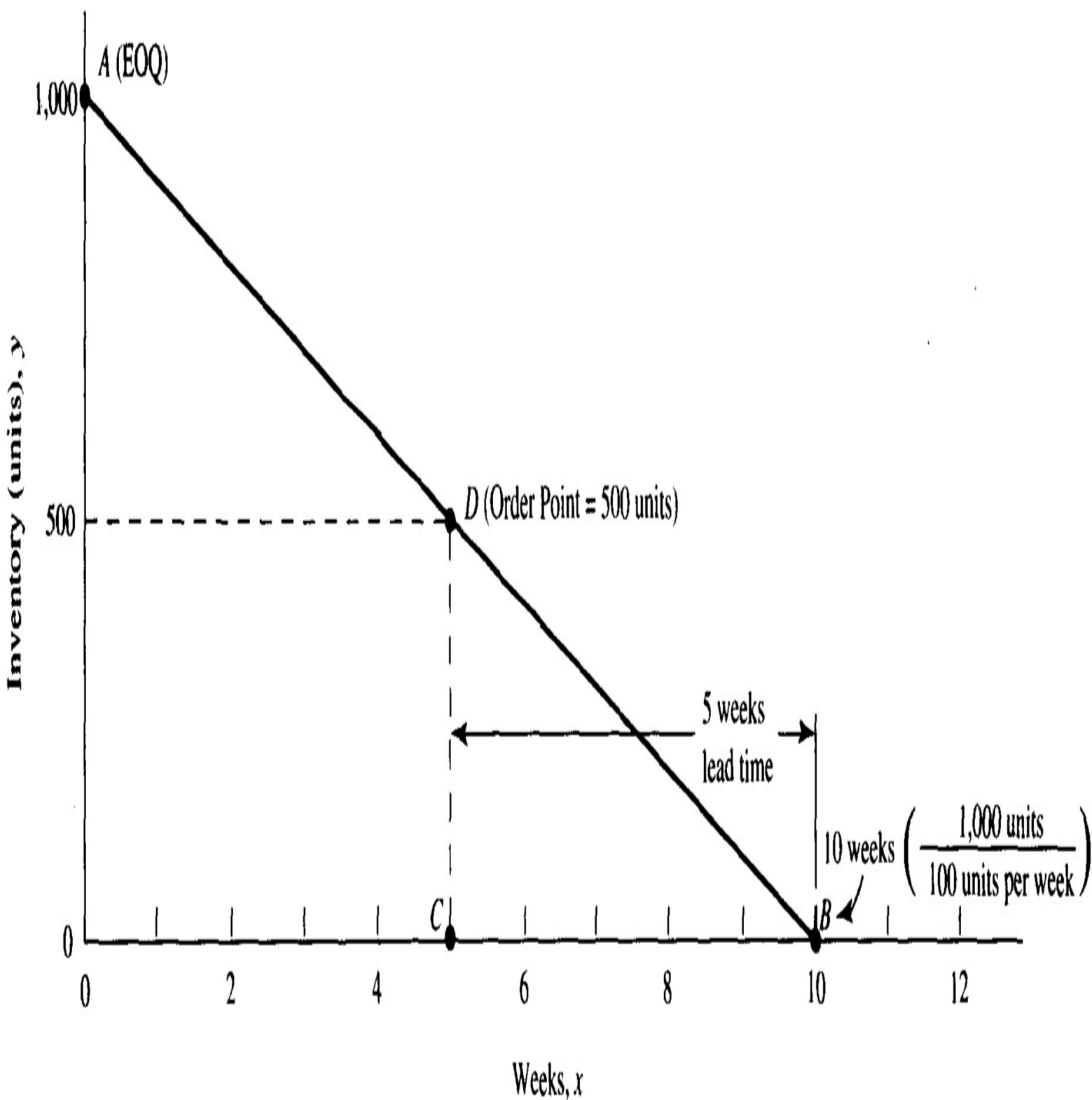


Fig. 12-4. Determining Order Point.

Step 1: Plot the EOQ on the vertical axis (point A).

Step 2: Plot the time supplied by each order (point B = units per order \div average inventory usage rate) on the horizontal axis and draw line AB.

Step 3: Subtract the lead time from point B and plot the result on the horizontal axis (point C).

Step 4: From point C draw a line perpendicular from the horizontal axis until it intersects line AB. The intersection point (point D) marks the order point.

EXAMPLE 14

See [Fig. 12-4](#).

12.8 SAFETY STOCK

Many companies carry a safety stock (additional inventory) as a cushion against possible stockouts. A safety-stock calculation should properly balance the risk of a stockout against the additional carrying costs incurred by the extra inventory.

(1) **Computation.** Safety stock is the number of additional units needed above the normal order point to offset possible increases in lead time and usage rate. Its computation is straightforward.

EXAMPLE 15

The normal lead time is 3 weeks, the normal inventory usage rate is 50 units per week, and the EOQ is 250 units. On the assumption that delivery could take as long as 5 weeks and the usage rate could be as much as 75 units a week, the order point for safety stock in units is calculated as follows:

Normal order point (3 weeks \times 50 units)		150
Usage for additional 2-week delay (50 units \times 2 weeks)	100	
Usage-rate variance*	<u>125</u>	
Safety stock		<u>225</u>
Revised order point		<u><u>375</u></u>

* Calculation: (75 units maximum usage - 50 units average usage) \times 5 weeks lead time.

(2) **Graphic Method.** The graphic presentation of safety stock is almost identical to the graphic presentation of the order point. The only difference is that now the safety stock must be added to the EOQ before plotting the EOQ on the vertical axis.

EXAMPLE 16

See [Fig. 12-5](#).

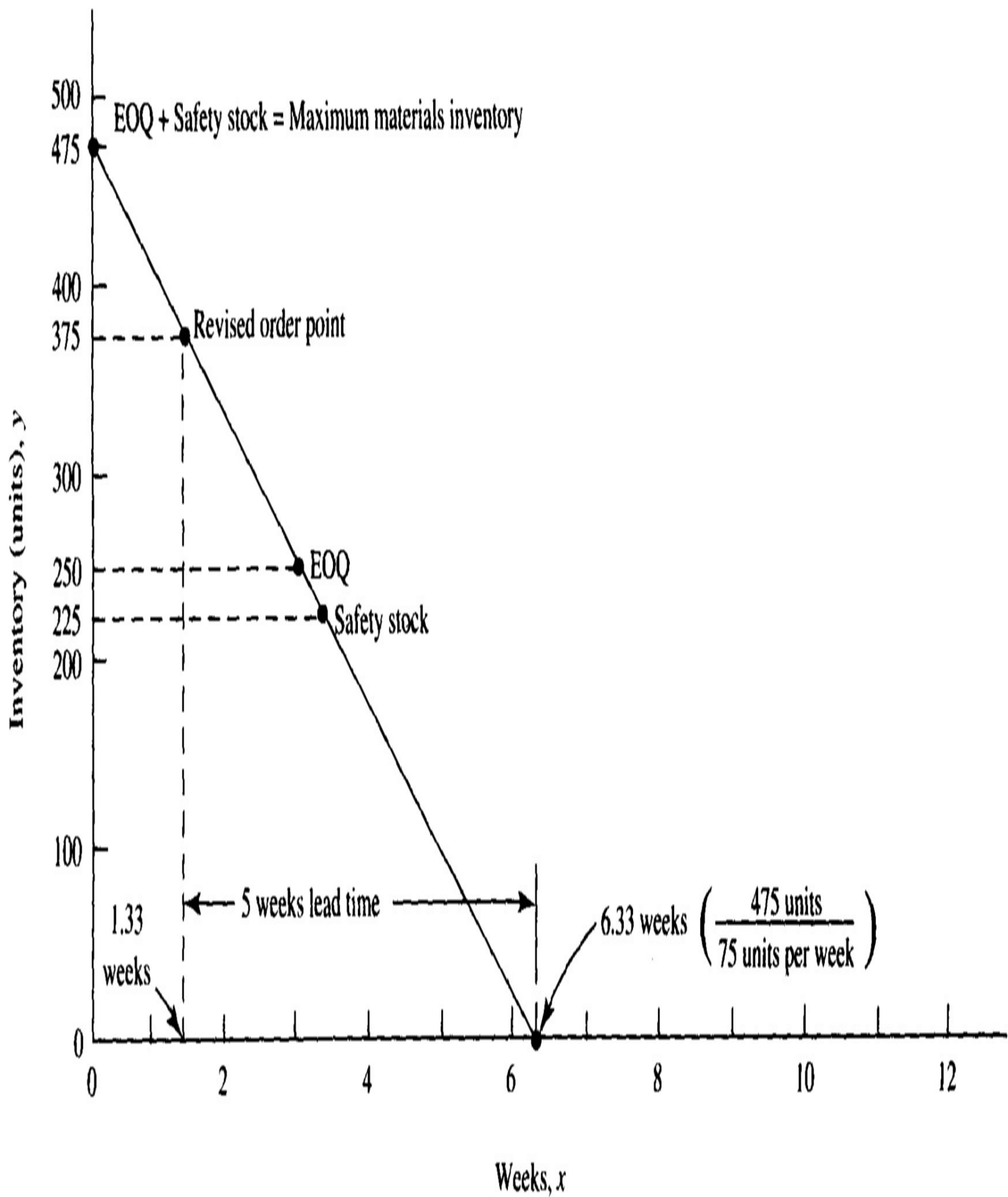


Fig. 12-5. Determining Safety Stock.

12.9 INVENTORY STOCKOUTS AND UNCERTAINTY

Decision-theory methods relying on statistical probabilities can be used to calculate the optimum safety stock for a company's inventory.

A probability distribution for various levels of inventory usage is developed, and these usage levels are compared with normal usage. The optimal safety-stock level is the amount with the least cost involved.

EXAMPLE 17

Assume the following information:

Total Usage and Probability of Stockout (2-Week Period)

Total usage (units)	150	200	250	300	350
Probability of stockout	0.25	0.40	0.20	0.15	0.05

Normal usage for a 2-week period is 200 units. Stockouts will occur whenever total usage exceeds normal usage (usage of 250, 300, and 350 units).

The following can be developed from the above data:

Stockout (Units)

	Probability		
	$P = 0.20$	$P = 0.15$	$P = 0.05$
Total actual usage (units)	250	300	350
Less: Normal usage (units)	<u>200</u>	<u>200</u>	<u>200</u>
Excess usage	<u><u>50</u></u>	<u><u>100</u></u>	<u><u>150</u></u>

When usage exceeds 200 units, stockout at the various levels of safety stock would be as follows:

Stockout	Safety Stock		
0	50	100	150
50	0	50	100
100	0	0	50
150	0	0	0

Stockout in Terms of Units and Cost

Safety Stock (Units)	Orders per Year (a)	Probability of Stockout	Stockout (units)	Stockout Cost (b)	Expected Stockout Cost (c)	Carrying Cost (d)	Total Cost
0	10	0.20	50	\$25	\$ 50.00		
	10	0.15	100	50	75.00		
	10	0.05	150	75	<u>37.50</u>		
					<u>\$162.50</u>	<u>\$ 0</u>	<u>\$162.50</u>
50	10	0.15	50	\$25	\$ 37.50		
	10	0.05	100	50	<u>25.00</u>		
					<u>\$ 62.50</u>	<u>\$10</u>	<u>\$ 72.50</u>
100	10	0.05	50	\$25	<u>\$ 12.50</u>	<u>\$20</u>	<u>\$ 32.50</u>
150	10	0	0	0	0	<u>\$30</u>	<u>\$ 30.00</u>

(a) Assume an annual requirement of 5,500 units and an EOQ of 550 units. Then, orders per year = $5,500 \div 550 = 10$.

(b) Assume stockout cost is $\$0.50 \times$ Stockout in units.

(c) Expected stockout costs = Number of orders per year \times Probability \times Stockout cost.

(d) Safety stock \times Carrying costs per unit per year; assume a carrying cost of $\$0.20$ per unit.

Safety stock of 150 units should be maintained because it entails the lowest total cost of \$30.

Solved Problems

12.1 Expected Value and Standard Deviation. The P.M.E. Co. has a choice between two projects. Using the following information, compute (a) the expected value and (b) the standard deviation, (c) Which project should be chosen?

Project A

Project P

Probability	Cash Flow	Probability	Cash Flow
0.25	\$3,000	0.10	\$ -0-
0.50	4,000	0.50	4,000
0.25	5,000	0.40	5,000

SOLUTION

(a) Expected Value

$$\bar{X} = \sum_{i=1}^n x_i P_i$$

Project A: $\bar{X}_A = 0.25(\$3,000) + 0.50(\$4,000) + 0.25(\$5,000) = \$4,000$

Project P: $\bar{X}_P = 0.10(0) + 0.50(\$4,000) + 0.40(\$5,000) = \$4,000$

(b) Standard Deviation

$$S = \sqrt{\sum_{i=1}^n (x_i - \bar{X})^2 P_i}$$

Project A:

$$\begin{aligned}
 S_A &= \sqrt{0.25(3,000 - 4,000)^2 + 0.50(4,000 - 4,000)^2 + 0.25(5,000 - 4,000)^2} \\
 &= \sqrt{250,000 + 0 + 250,000} = \sqrt{500,000} = 707.11
 \end{aligned}$$

Project P:

$$S_p = \sqrt{0.10(0 - 4,000)^2 + 0.50(4,000 - 4,000)^2 + 0.40(5,000 - 4,000)^2}$$
$$= \sqrt{1,600,000 + 0 + 400,000} = \sqrt{2,000,000} = 1,414.21$$

(c) Project A is preferable because it has a lower standard deviation, which means that it involves less risk.

12.2 PERT Network—Critical Path. Using the following information. (a) prepare a PERT network and (b) determine the critical path for the Moran Corporation's production of computers.

Activity	Activity Representation	T_L	T_E
<i>A</i>	1-2	42	42
<i>B</i>	1-3	50	42
<i>C</i>	1-4	38	35
<i>D</i>	2-5	30	30
<i>E</i>	3-5	25	22
<i>F</i>	3-4	28	26
<i>G</i>	4-5	33	27
<i>H</i>	4-6	37	24
<i>I</i>	5-6	22	22

SOLUTION

(a) PERT Network. See Fig. 12-6.

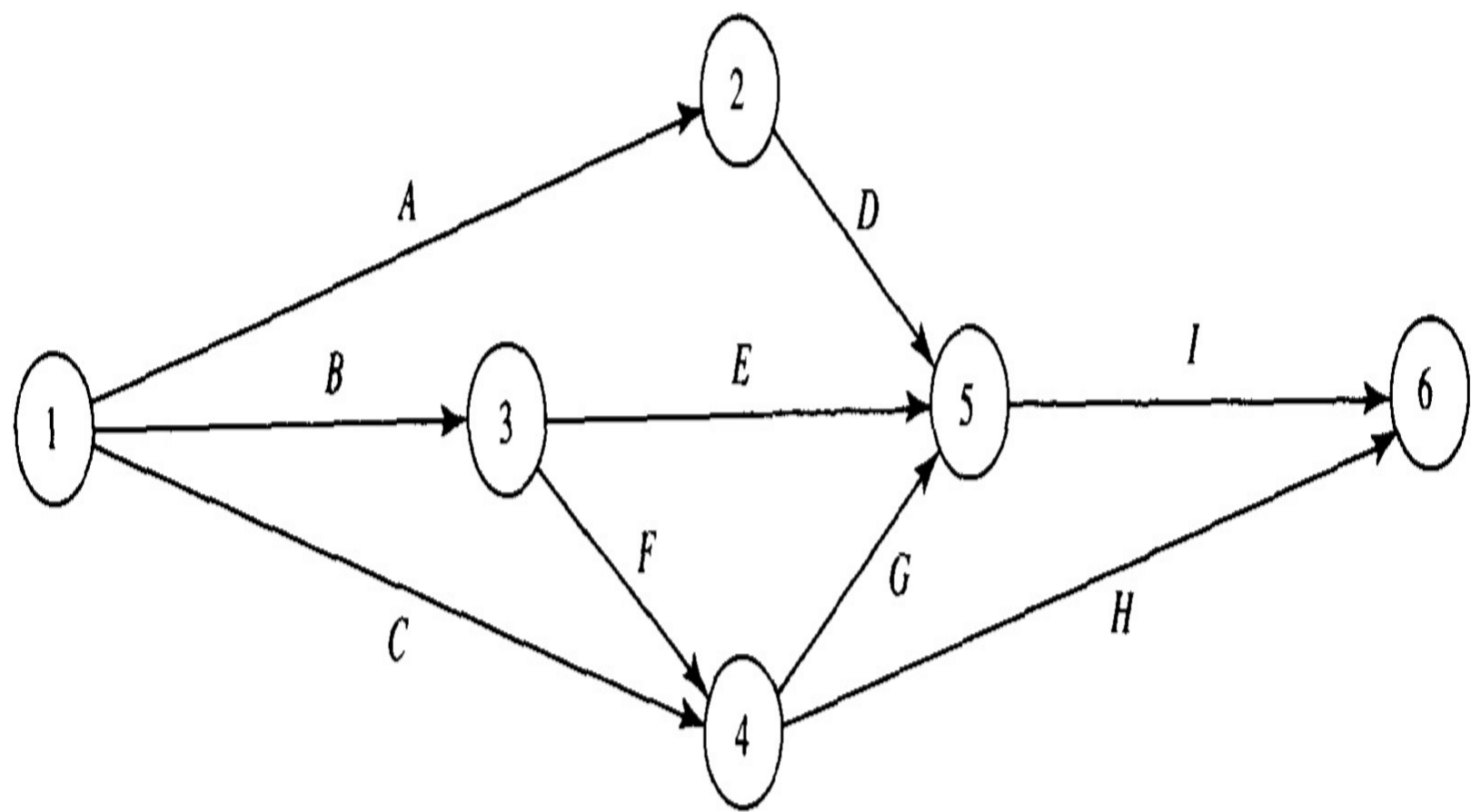


Fig. 12-6

(b) Critical Path

$$T_L - T_E = S$$

Activity	T_L	T_E	S
A	42	42	0
B	50	42	8
C	38	35	3
D	30	30	0
E	25	22	3
F	28	26	2
G	33	27	6
H	37	24	13
I	22	22	0

The critical path *ADI* is formed by those activities with zero slack.

12.3 EOQ. Kelly O'Donnell Inc. manufactures life jackets. The annual materials requirement is estimated to be 50,000 units, and the ordering cost is \$6 per order. The carrying cost is 10% of the unit inventory value. The materials cost per unit is \$25.

Compute the EOQ in units using (a) the tabular method for order sizes of 400, 450, 500, 550, and 600, (b) the formula method, (c) the graphic method for order sizes from 200 to 700 units.

SOLUTION

(a) Tabular Method

	Order size				
Quantity Data:	400	450	500	550	600
Number of orders (annual requirement ÷ order size)	125	111.1	100	90.9	83.3
Average inventory (order size ÷ 2)	200	225	250	275	300
Cost Data:					
Annual carrying costs (average inventory units × \$2.50)	\$ 500	\$ 562.50	\$ 625	\$ 687.50	\$ 750.00
Annual ordering costs (number of orders × \$6)	<u>750</u>	<u>666.60</u>	<u>600</u>	<u>545.40</u>	<u>499.80</u>
Total annual inventory cost	<u><u>\$1,250</u></u>	<u><u>\$1,229.10</u></u>	<u><u>\$1,225</u></u>	<u><u>\$1,232.90</u></u>	<u><u>\$1,249.80</u></u>

The EOQ would either fall between 450 and 500 units or 500 and 550 units. Further analysis would allow a more precise estimate of the EOQ.

(b) Formula Method

$$\text{EOQ units} = \sqrt{\frac{2 \times \text{RU} \times \text{CO}}{\text{S}}} = \sqrt{\frac{2 \times 50,000 \times \$6}{\$25 \times 0.10}} = \sqrt{\frac{600,000}{2.50}} = \sqrt{240,000} = 490 \text{ units}$$

(c) Graphic Method. See [Fig. 12-7](#).

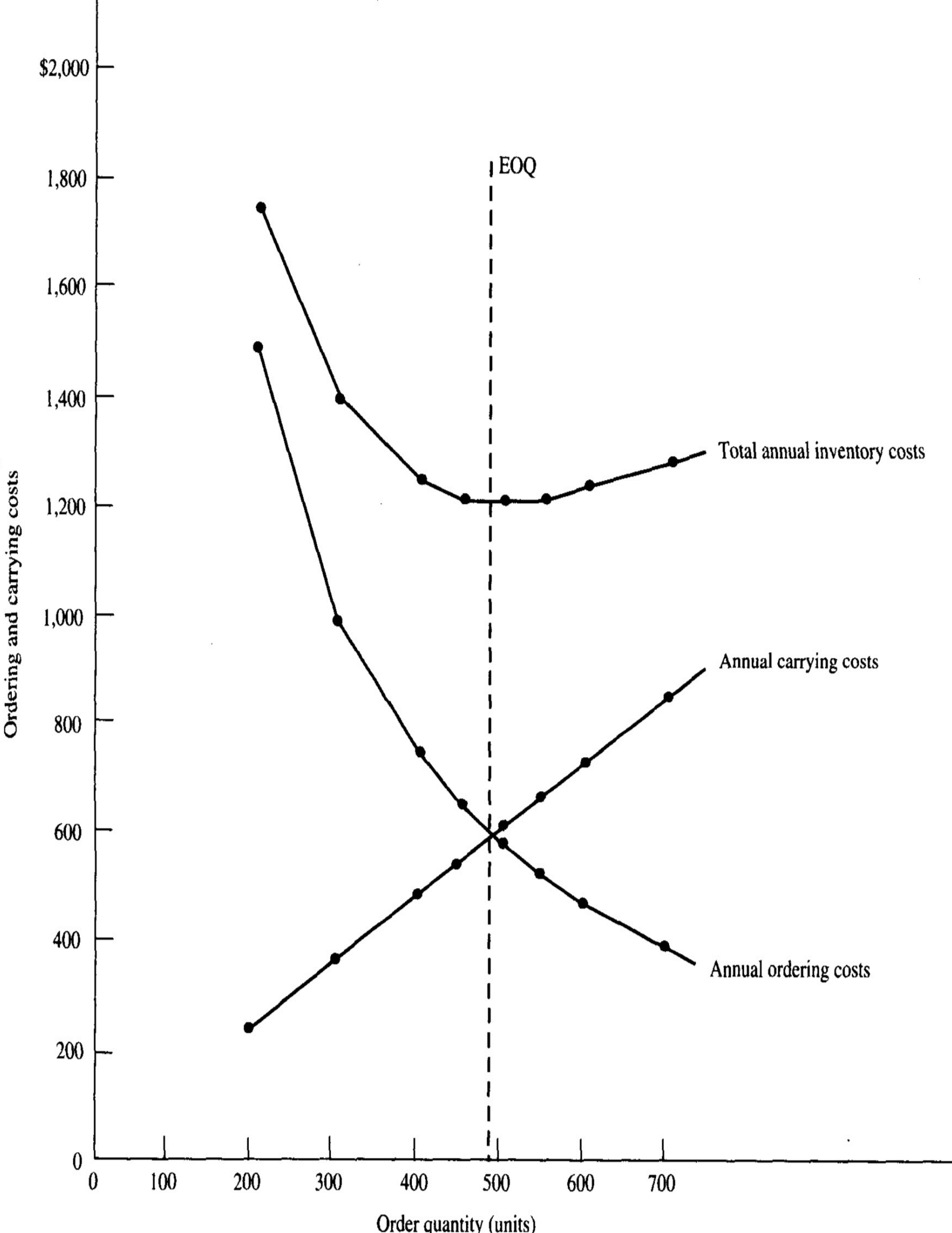


Fig. 12-7

12.4 Safety Stock—Computation. The EOQ for MGO Company is 250. The average inventory usage rate is 30 units per week, and the lead time is 2 weeks. Assuming that the maximum usage could be 40 units a week and possible delivery could take 4 weeks, compute the safety stock and revised order point.

SOLUTION

Normal order point (2 weeks \times 30 units)		60
Usage for additional 2-week delay (30 units \times 2)	60	
Usage-rate variance [(40 - 30) \times 4]	<u>40</u>	
Safety stock		<u>100</u>
Revised order point		<u><u>160</u></u>

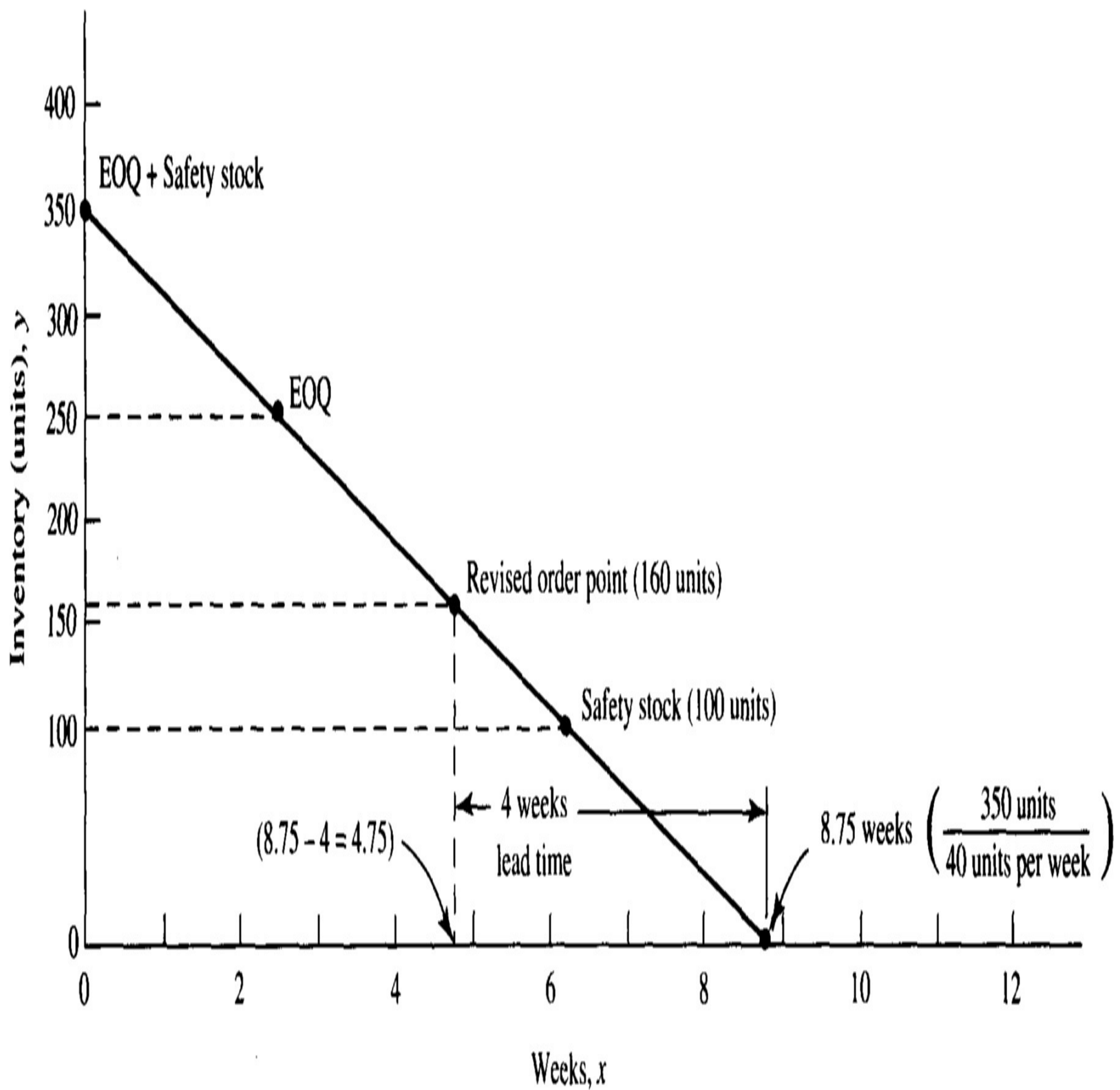


Fig. 12-8

12.5 Safety Stock. Kruta Corporation estimates its total usage and probability of stockout for a 4-week period to be as follows:

Total usage (units)	200	250	300	350	400
Probability of stockout	0.10	0.20	0.40	0.20	0.10

Assume a carrying cost per unit of \$0.20, a stockout cost of \$0.30 per unit, normal usage

of 250 units, annual requirements of 3,000 units, and EOQ of 150 units.

Determine the optimal level of safety stock.

SOLUTION

Stockout in Units

	Usage above 250 Units		
Probability	0.40	0.20	0.10
Total actual usage	300	350	400
Less normal usage	<u>250</u>	<u>250</u>	<u>250</u>
Excess usage	<u><u>50</u></u>	<u><u>100</u></u>	<u><u>150</u></u>
Stockout	Safety Stock		
0	50	100	150
50	0	50	100
100	0	0	50
150	0	0	0

Stockout in Units and Cost

Safety Stock (Units)	Orders per Year*	Probability of Stockout	Stockout (Units)	Stockout Cost†	Expected Stockout Cost‡	Carrying Cost§	Total Cost
0	20	0.40	50	\$15	\$120		
	20	0.20	100	30	120		
	20	0.10	150	45	<u>90</u>		
					<u>\$330</u>	<u>\$ 0</u>	<u>\$330</u>
50	20	0.20	50	\$15	\$ 60		
	20	0.10	100	30	<u>60</u>		
					<u>\$120</u>	<u>\$10</u>	<u>\$130</u>
100	20	0.10	50	\$15	<u>\$ 30</u>	<u>\$20</u>	<u>\$ 50</u>
150	20	0	0	0	0	<u>\$30</u>	<u>\$ 30</u>

* $\frac{3,000 \text{ units annually}}{150 \text{ units EOQ}}$

† $\$0.30 \text{ per unit} \times \text{Stockout units.}$

‡ $\text{Orders per year} \times \text{Probability} \times \text{Stockout cost.}$

§ $\$0.20 \text{ per unit} \times \text{Safety-stock units.}$

The optimal level of safety stock for the Kruta Corporation is 150 units because it entails the lowest cost of \$30.

Chapter 13

Decentralized Operations, Responsibility Accounting, and Transfer Pricing

13.1 INTRODUCTION

The degree of decentralization in a company has an important effect on the nature of the cost accounting system used. The question of how much decentralization is desirable remains controversial. In recent years, this question has become even more important, especially with the great expansion of multinational companies and the continuing trend of diversification and growth in conglomerate companies. In addition to the economic factors always present in decentralization, we now have a new factor, the political factor, which may be very significant for multinational companies.

As a company grows, top management must continually rearrange responsibilities among the various executives in order to maximize productivity. When it is desirable or necessary to rearrange physical units or other activities, top management must decide how to (1) divide activities and related responsibilities, (2) coordinate such divisions, and (3) evaluate divisional performance.

In the last few years, greater attention has been focused on responsibility accounting and management reports since they are useful in measuring how well assigned responsibilities are being carried out.

With the continuing trend toward decentralization, transfer pricing has become more significant in cost accounting.

Decentralized Operations

13.2 CONCEPTS OF ORGANIZATION

In the past, the major emphasis in organizational planning was on optimizing economic resources to achieve company objectives. However, in recent years the value of human resources has been recognized and become an important consideration in planning. Organizational planning may thus be defined as “the process of logically grouping activities, delegating authority and responsibility, and establishing working relationships that will enable both the company and the employee to realize their mutual objectives.”*

The principal approaches to arranging company activities are by (1) function, (2) product, and (3) geographic location.

13.3 FUNCTIONAL APPROACH

In the functional approach, company activities and responsibilities are organized according to major functions, such as marketing, manufacturing, and finance. Generally, control for each function resides at the vice-president level. For example, the marketing employees report upward from the lowest operating level to the vice-president of the Marketing Division. An important disadvantage is that key decisions are made at the top and passed downward, which is often a time-consuming process.

EXAMPLE 1

Fig. 13-1 illustrates the functional organization of three divisions, Marketing, Manufacturing, and Finance, each headed by a divisional vice-president. To keep the chart uncluttered, further details are shown only for the Manufacturing Division, which is composed of three plants. Each plant manufactures industrial, consumer, or government products and is headed by a plant manager. The details for the Consumer Products Plant illustrate how further division by function might be accomplished. Each of the departments in the Consumer Products Plant is involved in one of three types of operation (forming, assembly, or finishing) and is headed by a department supervisor.

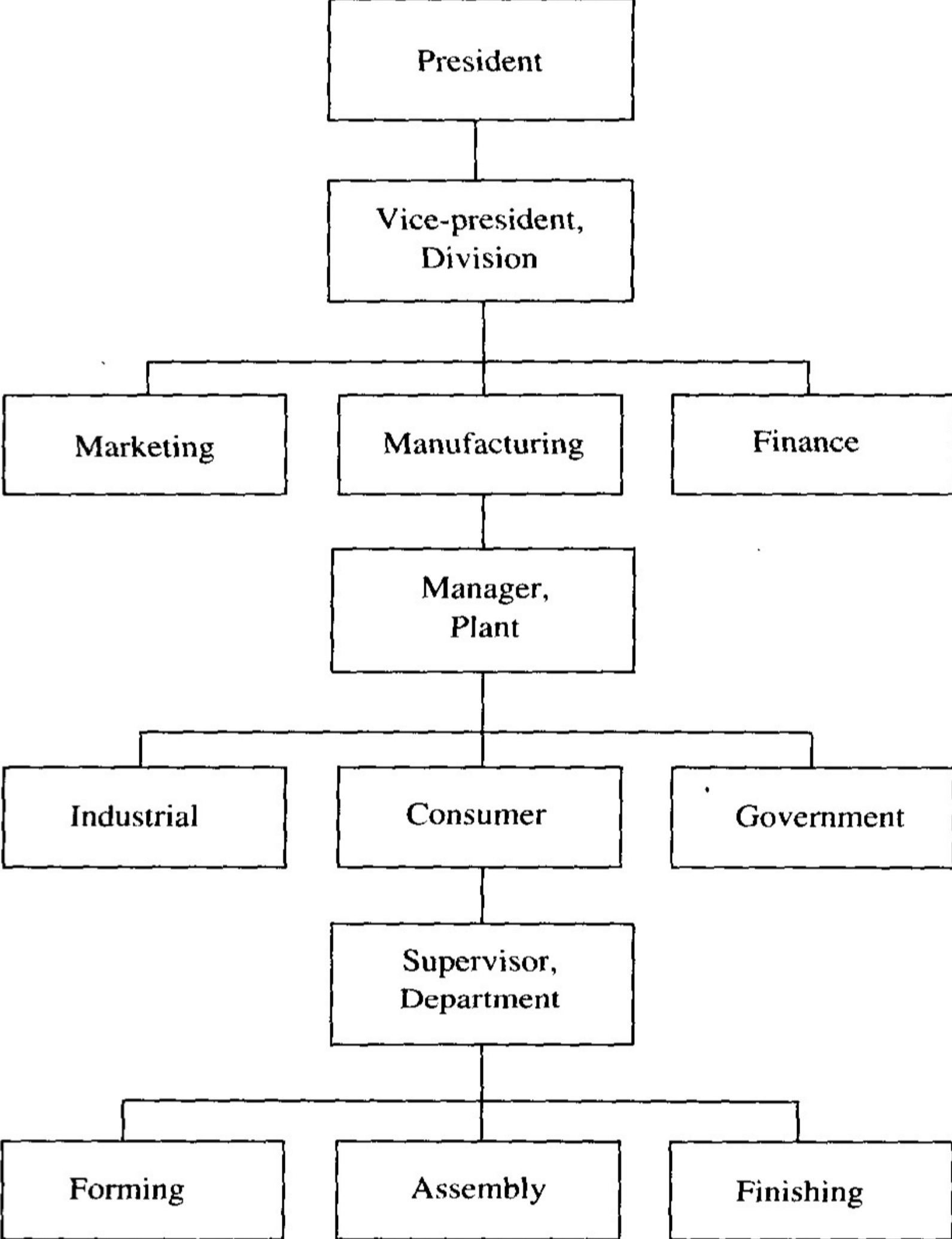


Fig. 13-1. Organization Chart: Functional Approach.

13.4 PRODUCT APPROACH

In the product approach, the activities and responsibilities of a company are organized according to the type of product or group of products manufactured. For example, instead of the one general marketing division for the company, as in [Fig. 13-1](#), there would be three separate marketing departments. An important advantage in this approach is that it offers the possibility of more effective coordination of the activities and functions relating to a particular product.

EXAMPLE 2

[Fig. 13-2](#) shows a product chart with three general product divisions: Agricultural, Hardware, and Plastics. Each product division would have its own Marketing, Manufacturing, and Finance Department (not shown). Further details for the Hardware Division show that it is composed of three plants (manufacturing hand tools, nails, or insulation), each having a plant manager. Further details are also given for the Nails Plant, which has three departments (Mixing, Forming, and Packaging), each with a department supervisor.

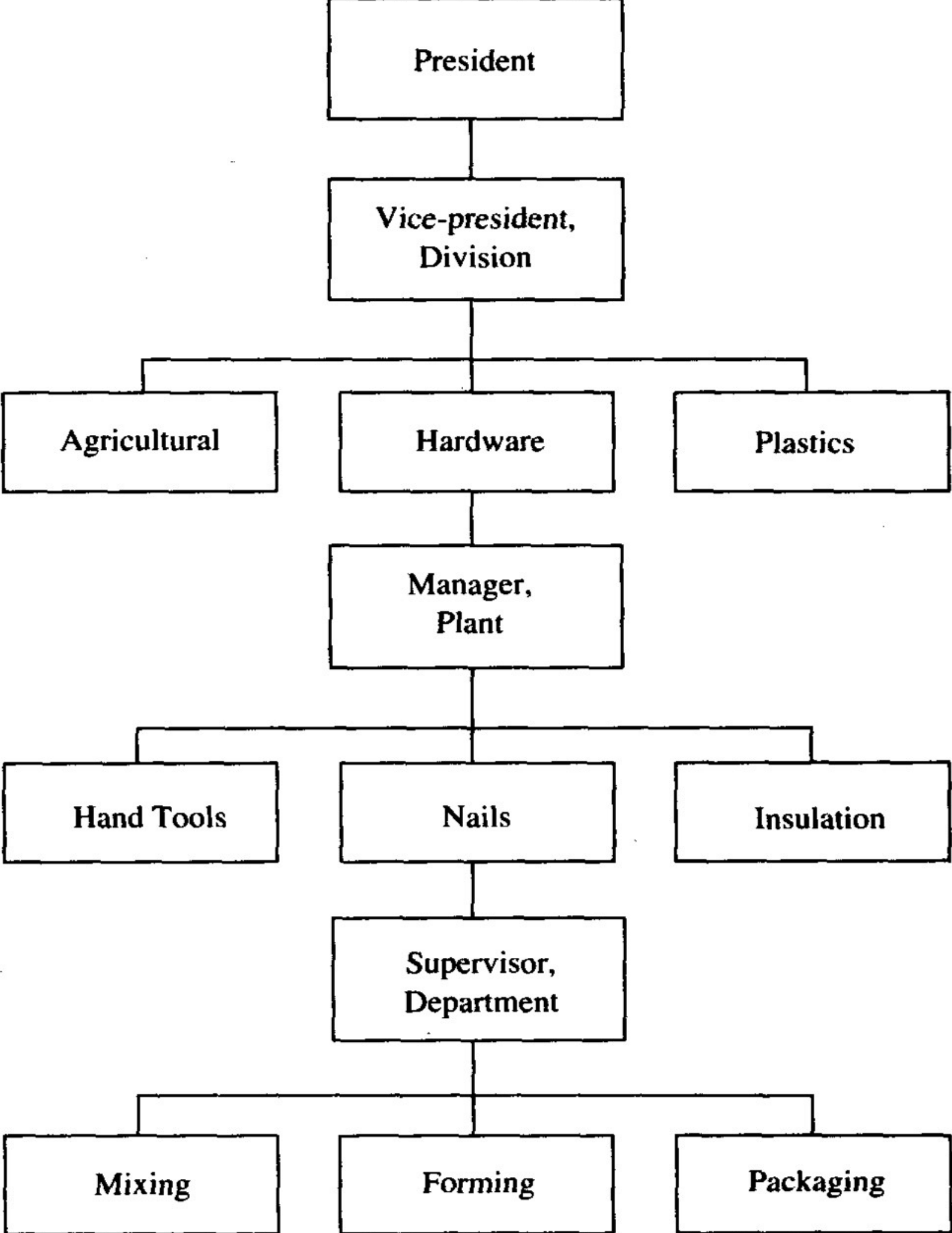


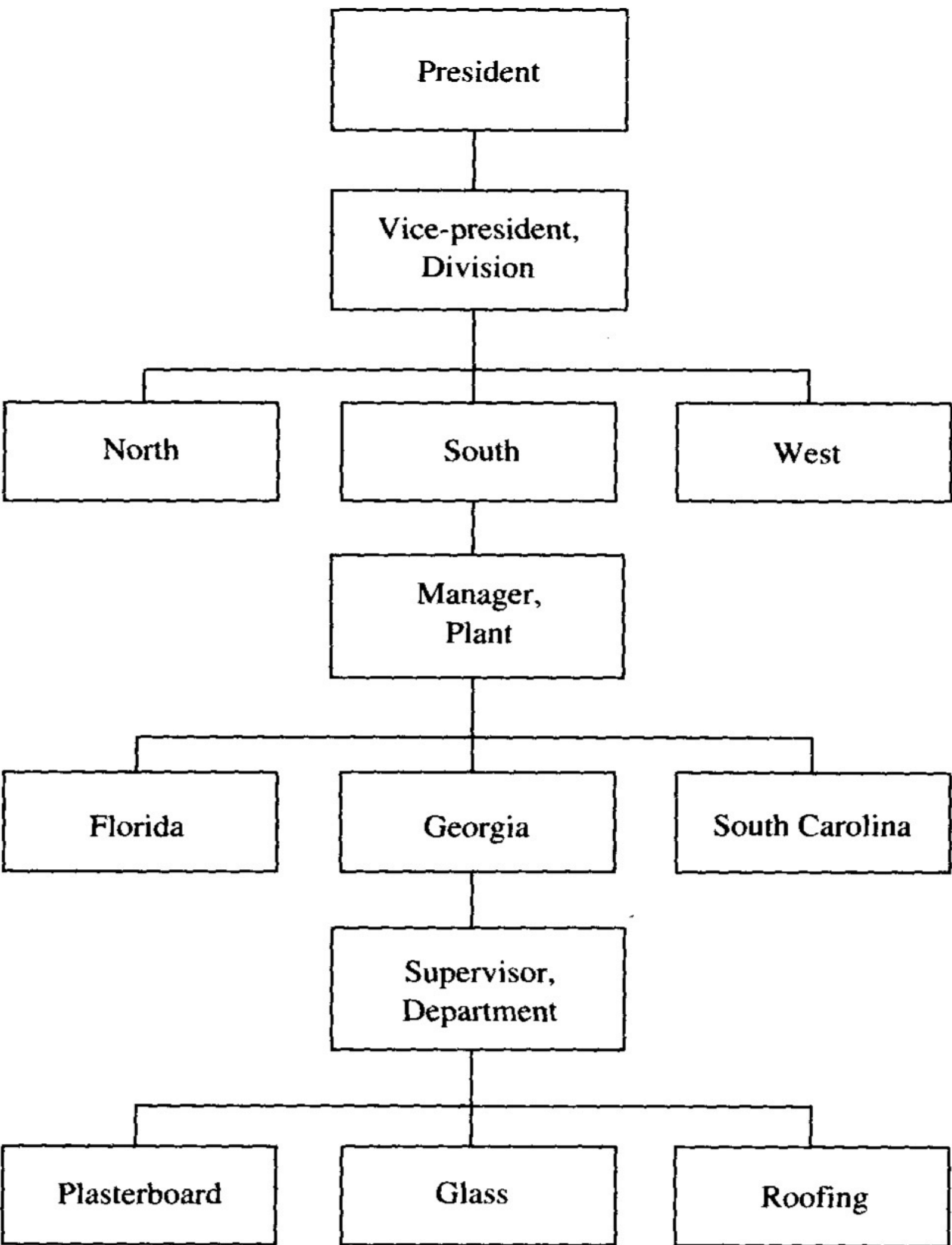
Fig. 13-2. Organization Chart: Product Approach.

13.5 GEOGRAPHIC APPROACH

In the geographic approach, the activities and responsibilities are organized according to geographical area. The managerial responsibility encompasses all functions and all products in a particular territory. This type of approach is often used when the product is bulky or heavy and substantial transportation charges are involved. Such charges are minimized when shipments are made from the plant or warehouse closest to the customer.

EXAMPLE 3

Fig. 13-3 shows an organization chart with three general divisions: North, South, and West. Further details for the South Division show that there are plants in Florida, Georgia, and South Carolina, each with a plant manager. The representative details for the Georgia plant show three departments, each with a departmental supervisor and producing plasterboard, glass, or roofing products.



13.6 ADVANTAGES AND DISADVANTAGES OF DECENTRALIZATION

The principal advantages are as follows:

- (1) Top managers have more time to devote to general planning since they are not burdened with routine daily decisions.
- (2) The decision-making task is distributed among more personnel so that each person has enough time to give matters sufficient attention.
- (3) Better control can be achieved, as the manager can move quickly to make needed corrections.
- (4) Managers are better motivated, as they have more control over those matters on which their performance is measured.
- (5) Managers are more likely to exercise initiative in such matters as “comparison shopping” in order to reduce costs of outside materials. Comparison of internal and external costs tends to keep internal costs, such as transfer pricing of intracompany goods or services, in line.
- (6) As managers become more proficient in decision making, they become more qualified for higher management positions.

The principal disadvantages are as follows:

- (1) The extent of authority and responsibility to be decentralized is difficult to determine.
- (2) Managers needed to head the decentralized units must be selected and trained, a process that is often time-consuming and expensive.
- (3) The varied activities of decentralized units must be coordinated, a difficult task.
- (4) Evaluating the performance of the units and the individual managers is often problematic.

Responsibility Accounting

13.7 NATURE OF RESPONSIBILITY ACCOUNTING

Originally, most cost systems were established to determine product costs. The emphasis in responsibility accounting is on *who* spent the money and *why* it was spent, rather than on *what* the expense was. Thus we can define responsibility accounting as “a system designed to accumulate and report costs by individual levels of responsibility... Each supervisory area is charged only with the cost for which it is responsible and over which it has control”.*

13.8 RESPONSIBILITY CENTERS

When an entity is divided into segments with managers having responsibility over specific areas, the segmented areas are known as *responsibility centers*. Three types of responsibility centers are commonly identified: cost or expense center, profit or earnings center, and investment center.

Cost or Expense Center. This is a segment of the organization that has been assigned control over only the incurrence of expenses or costs. A cost or expense center has no control over sales or marketing activities. For example, a department within a factory may be considered a cost or expense center if the manager is responsible only for controlling costs and has no responsibility over revenues.

Profit or Earnings Center. This segment of the organization is assigned control over both costs and revenues. Net income and contribution margins can therefore be computed for a profit center. For example, an entity that makes wood furniture may cut lumber in one department and assemble the furniture in another department. The first department can be considered a profit center if the cut lumber is “sold” to the second department. The selling price of this internal sale is called the *transfer price* (see [Section 13.12](#) for further analysis of transfer pricing) and may be used as revenue for the first department.

Investment Center. This center differs from a profit center in that it has control not only over revenues and costs but also over invested funds. If the manager of the lumber-cutting department also had control over how much was invested in the department, this segment would then be considered an investment center. In addition to net income and contribution margin, the return on investment can be computed for investment centers.

13.9 ESSENTIALS OF CONTROL

No matter how well-designed a system is, it will not be successful unless it has the support of the people who operate the system. The system must be based on *people responsibility*, as it is people who incur costs and should be held accountable for each expenditure. The principal controls for incurring of costs are as follows: (1) An organization plan that establishes the objectives and goals to be achieved.

- (2) Delegating the authority to incur costs and designating responsibility for such costs through a system of policies and procedures.
- (3) Motivating individuals by developing standards of performance and offering incentives.
- (4) Timely reporting and analysis of deviations in performance from stated goals or budgets by means of a system of records and reports.
- (5) A system of appraisal or internal auditing to ensure that unfavorable variances are highlighted and that corrective measures are applied.

13.10 RESPONSIBILITY ACCOUNTING REPORTS

Responsibility accounting reports are prepared according to the levels of responsibility designated on the organization chart. At each level the direct costs incurred by the unit manager are listed, followed by the costs incurred by each of the subordinate managers. In some companies the indirect costs are also shown, so that top management and the unit manager can be aware of the total cost related to each unit.

On the responsibility reports a detailed breakdown of costs is shown for the lower levels. Reports prepared for vice-presidents usually show only plant totals. Vice-presidents who need more information can get it from the plant managers. At each level budgeted costs are compared with actual amounts. The resulting variances can then be analyzed at the appropriate levels.

Some companies prefer to designate the president’s office as level 1 (or A) and the departments,

or lower levels, as 2, 3, *etc.* Others prefer to use the reverse designation, with the lowest level as level 1 or A. In the following description, the highest level is designated as 1, but the reverse order is used in [example 4](#).

Level 1: President. In the president's report the cost of that office is shown first, then the totals for the division for which each vice-president is responsible.

Level 2: Vice-President. On the report for the vice-presidents' level, the cost of that office is shown first and then the total for one of the three functions (Sales, Marketing, or Finance). Details of this report are illustrated for the Sales Division only. The total of the details on a vice-president's report equals one of the divisional totals on the president's report.

Level 3: Manager. In [example 4](#) the Sales Division is divided into three territories, each with a plant manager. Each manager's report would show first the cost of that office, then the total cost for the territory. Expenses for territory 1 serve to illustrate the details of this report. The total of the details on each sales manager's report is also shown on the report for the next higher level, the vice-president of sales.

EXAMPLE 4

An organization chart ([Fig. 13-4](#)) and responsibility accounting reports for the Lynbob Company are presented below. The company has three levels of control: president, vice-president, and manager. This report emphasizes the sales function of the company by presenting the costs for sales managers and the vice-president of sales in detail.

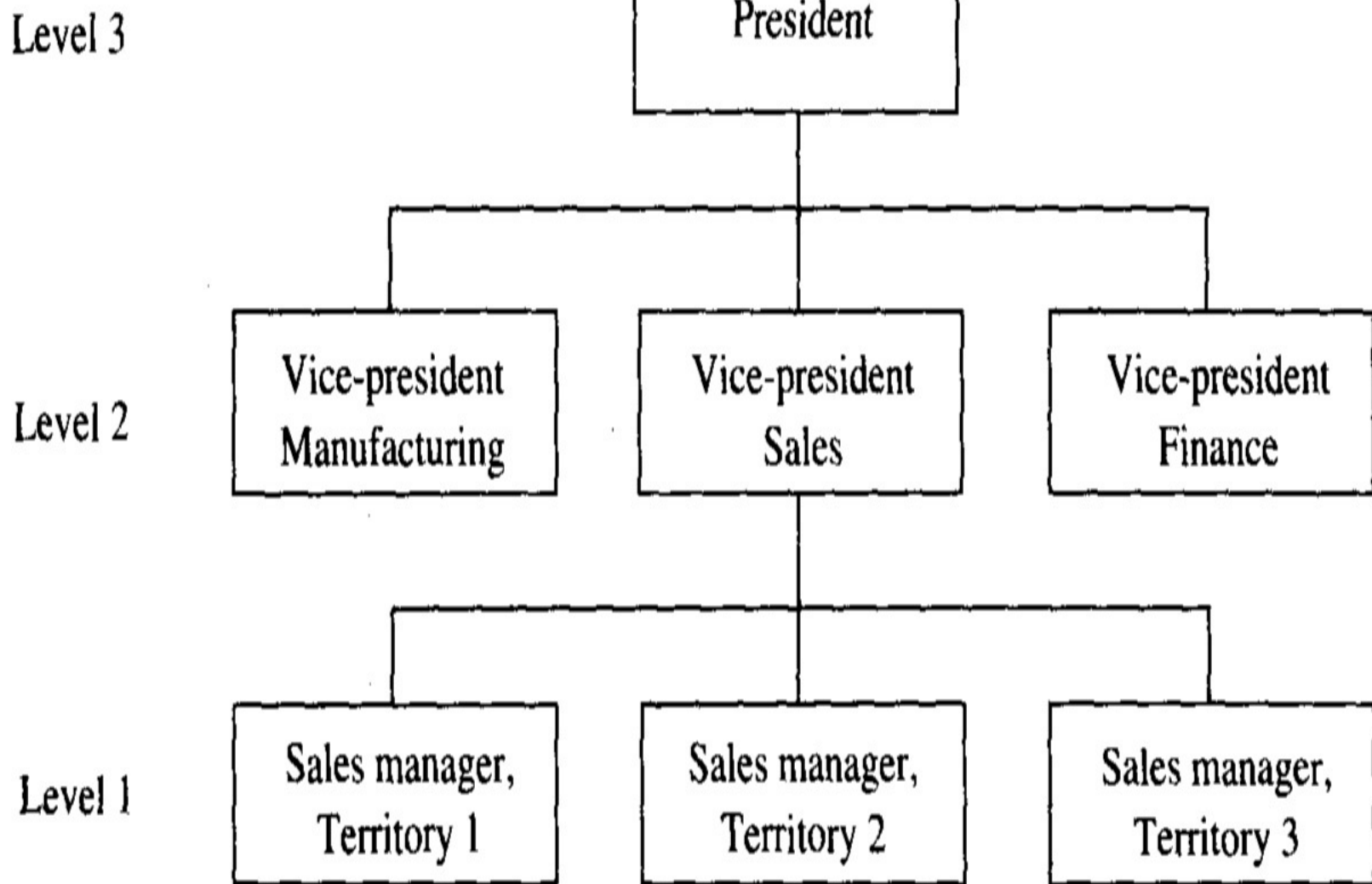


Fig. 13-4. Organization Chart: Levels Reversed.

Level 1: Sales Manager, Territory I. These costs are directly controllable by the sales manager and are composed of office expenses and the expenses incurred by salespeople. The total controllable cost at this level becomes part of the cost of the vice-president of sales, and as such, is entered on the report for level 2.

Level 2: Vice-President, Sales. At this level, costs of the vice-president's office are shown, followed by the costs incurred by each of the three sales managers. The costs of the three sales territories were compiled from the reports prepared by the sales managers. The total controllable cost of this level becomes part of the cost of level 3, the president.

Level 3: President. In addition to the costs incurred by the president's office, included at this level are the costs of the vice-presidents of the three divisions of the company. The costs are compiled from the reports submitted by the vice-presidents.

Responsibility Reports Controllable Costs Month of April, 19XX

Current Month		(Favorable)
Budget	Actual	Unfavorable
		Variance

Level 3: President

President's office	\$212,000	\$208,600	\$(3,400)
VP Sales	124,500	123,600	(900)
VP Finance	107,000	109,800	2,800
VP Manufacturing	<u>125,800</u>	<u>131,000</u>	<u>5,200</u>
Total controllable cost	<u><u>\$569,300</u></u>	<u><u>\$573,000</u></u>	<u><u>\$ 3,700</u></u>

Level 2: VP Sales

VP Sales office	\$ 25,000	\$ 22,300	\$(2,700)
Territory 1	31,500	34,800	3,300
Territory 2	33,000	30,500	(2,500)
Territory 3	<u>35,000</u>	<u>36,000</u>	<u>1,000</u>
Total controllable cost	<u><u>\$124,500</u></u>	<u><u>\$123,600</u></u>	<u><u>\$ (900)</u></u>

Level 1: Sales Manager, Territory 1

Sales commissions	\$ 14,500	\$ 15,000	\$ 500
Travel	13,000	17,000	4,000
Advertising	<u>4,000</u>	<u>2,800</u>	<u>(1,200)</u>
Total controllable cost	<u><u>\$ 31,500</u></u>	<u><u>\$ 34,800</u></u>	<u><u>\$ 3,300</u></u>

13.11 ESSENTIALS OF GOOD PERFORMANCE REPORTS

Timely action reports are essential in responsibility accounting. Reports vary, of course, with needs and wishes of different managements, but the following basic considerations should govern the design and distribution of responsibility reports: (1) *Fit the report to the organization chart.* Develop individual reports for each organizational level.

- (2) *Make reports timely.* Determine whether the report should be submitted daily, weekly, monthly, etc.
- (3) *Use action reports.* Present data in a manner that will motivate management to take corrective action.
- (4) *Issue reports sooner.* Make flash reports when practical.
- (5) *Pinpoint responsibility.* Make individual responsibility apparent in the reports.
- (6) *Simplify and clarify.* Arrange data in logical sequence; interpret data; use short titles.
- (7) *Show comparisons, ratios, trends, etc.* Show deviations as favorable or unfavorable.
- (8) *Make the system flexible.* Revise reports as needed and change emphasis where required; issue special reports, if needed.
- (9) *Consider cost.* Avoid duplication; obtain data from regular processing; investigate alternate methods of reproduction, presentation, etc., to reduce costs.
- (10) *Use visual aids.* Use visual presentation; it saves management time, since relationships and trends are often clearer.
- (11) *Control distribution of reports.* Make sure the individual responsible gets the report; fix responsibility for distribution and updating of list.

Transfer Pricing

13.12 SIGNIFICANCE OF TRANSFER PRICING

Transfer pricing refers to the basis for transferring goods or services from one affiliated unit to another within the company. With the continued trend toward decentralization, the problem of determining an equitable transfer price has become much more significant in cost accounting. The transfer price can have an important impact on the profit of each division and possibly on the performance evaluation of each division and division manager. The transfer price has an important effect on make-or-buy decisions, that is, whether to make, or continue to make an intermediate product for intracompany transfer or to buy the product outside the company.

13.13 OBJECTIVES OF TRANSFER PRICING

The most important overall objective of transfer prices is to ensure that the interests of any division do not conflict with the interests of the company as a whole. For example, a bonus plan may be based on sales volume rather than profit or return on investment, and a particular division may concentrate on selling products with high volume but low profit margins. The principal objectives of transfer pricing are to furnish data for:

- (1) Pricing and capital-budget decisions
- (2) Make-or-buy decisions
- (3) Evaluation of divisional performance
- (4) Evaluation of divisional managers' performance

13.14 TRANSFER PRICING METHODS

The particular pricing method chosen must be the one most suitable for company operations. The principal methods used to establish transfer prices are cost, cost plus, market price, negotiated price, dual prices, and incremental costs.

13.15 COST METHOD

Most companies use cost or cost plus for determining transfer prices. The cost may be based on actual, standard, variable, or any other reasonable estimate of cost. When either actual or full costs are used, there may not be enough incentive for the selling division to reduce inefficiencies or control its own costs. Generally, standard costs or budgeted costs are used since the selling division would try to keep its actual costs as close to the standard as possible.

When a decentralized company uses variable costs, difficulties may arise because of the wide differences between that price and the price to outsiders. Divisions with a large proportion of intracompany transfers are likely to show a low earnings ratio and low return on investment unless adjustments are made. One way to help solve this problem is by using dual prices, described in [Section 13.19](#). Another way is to use cost plus a percentage of cost, which may bring the transfer price in line with the market price. This method is described next.

13.16 COST PLUS METHOD

Under this method a predetermined percentage is added to the cost. Thus if the cost is \$0.60 per pound and the transfer price is *cost plus 30%/r*, the goods will be transferred at \$0.78 per pound [$\$0.60 + \$0.18, (\$0.60 \times 30\%)$]. Often, outlay costs or incremental costs are used as a base to which the percentage is added.

As described in [Section 13.21](#), the percentage added on interdivisional profit has to be eliminated when the total company financial statements are prepared.

EXAMPLE 5

The J. Connell Company is an integrated manufacturing company with a number of autonomous

divisions. Division A transfers all its output to Division B at a transfer price of \$32 plus 25%, or \$40. The manager of Division B complains that the transfer price is too high, since the same item can be bought outside the company for \$37. The cost to Division A includes \$28 of variable costs and \$4 of fixed costs, at normal capacity. The division has some idle capacity at present. Should the item be purchased outside at the lower price?

	Division B	Company
	Costs	Costs
Outside price	\$37	\$37
Transfer price	40	
Cost to company	<u> </u>	<u>32</u>
Profit (loss)	<u><u>\$(3)</u></u>	<u><u>\$ 5</u></u>

Divisional results are a loss of \$3 per unit when company products are used. However, for the company as a whole, results are a profit of \$5 per unit. Therefore, it is preferable to continue transferring goods. However, to satisfy the manager of Division B, perhaps a shift to another transfer-pricing method should be considered.

13.17 MARKET PRICE METHOD

Use of the market-price method is generally satisfactory in the event that a competitive market price is obtainable. Often a transfer price lower than a competitive market price is justified since lower costs are involved due to the absence of advertising and other selling outlays. Advantages of this method include the fact that better control of purchases can be maintained and larger quantities can be produced and shipped at minimal cost. Furthermore, there is a guaranteed market, and there is assurance of good quality and dependable delivery.

The market-price method may have some disadvantages such as the unavailability of a market price for the exact product or for the intermediate product. In some cases the price obtained may not be reliable, or it may not be from a stable source. Sometimes a vendor will give a low bid for the first order and then increase the price for future orders. Generally, it is desirable to maintain contact with more than one seller or buyer so that reasonable and satisfactory market prices can be maintained.

EXAMPLE 6

The Panda Company has two manufacturing plants: Plant A, the processing unit, and Plant B, the finishing unit. Both plants are autonomous, so Plant A has the option of selling its finished product to

Plant B or to outside customers. Plant B has the option of buying from Plant A or from outside suppliers. The sales price of Plant A's product is \$ 14 per unit, with variable costs of \$8 and fixed costs of \$4 per unit. The sale price of Plant B's product is \$22 per unit, with transfer costs of \$14 per unit and additional variable costs of \$4 per unit. [Fig. 13-5](#) illustrates the transfer operation, and the profit is shown in the summary.

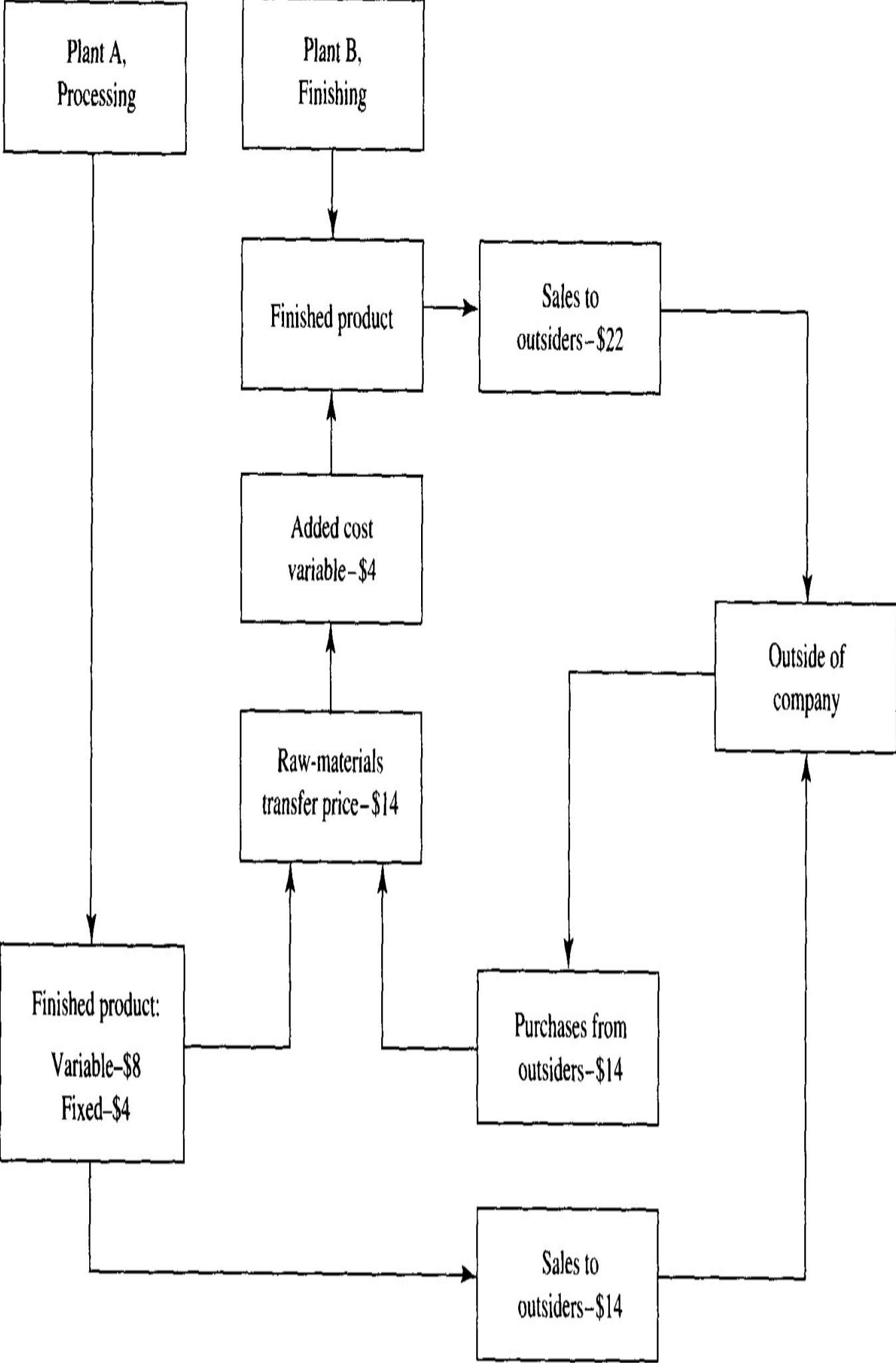


Fig. 13-5. The Panda Company, Transfer-Pricing Chart, 19XX.

Summary

	Plant A	Plant B	Company
Selling price	<u>\$14</u>	<u>\$22</u>	<u>\$22</u>
<i>Finishing</i>			
Variable costs		\$ 4	\$ 4
Transfer price		14	
<i>Processing</i>			
Variable costs	\$ 8		8
Fixed costs	<u>4</u>	<u> </u>	<u>4</u>
Total costs	<u>\$12</u>	<u>\$18</u>	<u>\$16</u>
Profit	<u>\$ 2</u>	<u>\$ 4</u>	<u>\$ 6</u>

13.18 NEGOTIATED PRICE METHOD

Generally a negotiated price, which is arrived at through bargaining between the buying and selling divisions, gives division managers the greatest control over divisional profit. The serious difficulty with this method is that negotiations take time and require the development and analysis of much data. Also, there may be frequent requests for revisions. Possible overemphasis on divisional welfare rather than company welfare may result. Sometimes stalemates occur, and top management must intervene to resolve the issues. At times ill feelings may develop between the division managers involved that more than offset the benefits gained.

13.19 DUAL PRICES METHOD

In many cases a transfer price may cause much dissatisfaction for a divisional manager even though the company as a whole may earn a profit by transferring goods. For example, Division X transfers

most of its output to Division Y at a price of \$10. Everyone in company management is aware that the transfer price is significantly lower than the regular selling price (\$14) and that the resulting profit of Division X will therefore be lower. Consequently, the manager of Division X is unhappy, since selling only to outsiders would greatly increase the profit of the division. The fact that divisional operating reports are widely distributed further aggravates the matter. As a result, the company is considering a switch to the dual pricing method, whereby Division Y would still be charged \$10, the transfer price, but Division X would be given credit for a sale at the full market price of \$14. In preparing the consolidated financial statements, this difference would have to be eliminated, as would any interdivisional profit.

13.20 INCREMENTAL COSTS METHOD

In certain situations, incremental costs may be the most appropriate transfer price. When a plant is operating with idle capacity and a special order is requested, incremental analysis should be employed to determine whether the special order should be accepted. In incremental analysis only the additional costs incurred in accepting an order are considered, and the allocation of existing fixed costs are ignored. Incremental analysis allows for no contribution margin and treats a division more as a cost center than as a profit center.

EXAMPLE 7

The typing pool is considered to be a service department of Ivy College. The pool charges its time at its total standard cost of \$8 per hour; 80% of this amount is attributable to fixed charges. The English Department needs a special report typed. A typist is available with sufficient free time to do this job. The chairperson of the English Department wants the report done at the lowest possible cost since the department is already overbudgeted for secretarial services. The report could also be typed at Redi-Type service company for \$6 per hour. What should the chairperson do?

It would be in the best interest of Ivy College to have the report typed by its typing pool. The important cost to consider is not the \$8 per hour total standard cost but the \$1.60 per hour ($\$8 \times 20\%$ variable costs) additional costs incurred for paper, ribbons, etc., for this particular job. The chairperson should discuss incremental analysis with the manager of the typing pool and arrange for the English Department to be charged only \$1.60 per hour for the special report. It would not be in the best interest of Ivy College for the English Department to pay \$6 per hour externally for a service it can provide for \$1.60 per hour.

13.21 ACCOUNTING ENTRIES

According to generally accepted accounting principles, profit can be made only on sales made outside the company. Therefore, it is necessary to eliminate entries of all intracompany profit when preparing company financial statements. Unless elimination entries are made, the sales, accounts receivable, cost of goods sold, and inventory accounts will be overstated by internal transfers.

In a large company, unearned profit may have to be eliminated at a number of different levels. For example, one plant may sell to another plant in the same division, thereby creating *interplant profit*; or to a plant in another division, creating *interdivisional profit*; or to an affiliated corporation, creating *intracompany profit*. Some companies may have more than one such profit account, but

many use only one account and make adjustments to it at the end of each month. Generally, company statements are created at company headquarters, divisional statements at divisional headquarters, and plant statements (primarily cost details) at each plant. A monthly report containing the description, quantity, and cost of all goods received from affiliated units should be submitted by each plant to company headquarters. The markup on each item can then be determined and the total eliminated from intracompany profit.

EXAMPLE 8

The Brett Branning Company uses the cost plus transfer method at standard cost plus 25%. During June, Division A transferred materials with a standard cost of \$6,000 to Division B at a transfer price of \$7,500. At the end of the period, Division B had on hand \$3,000 of transferred goods. The following shows the entries on the divisions' books and on the company headquarter's books when eliminations are made.

Divisions' Books

To record the transfers:

Division A		
Accounts receivable, Division B	\$ 7,500	
Interdivisional sales		\$7,500
To record transfers by shipping division		
Interdivisional cost of goods sold	6,000	
Inventory		6,000
To record cost of transfers by shipping division		

Division B		
Inventory	7,500	
Accounts payable, Division A		7,500
To record transfers by receiving division		

Headquarter's Books

Accounts payable, Division A	\$ 7,500	
Accounts receivable, Division B		\$7,500
To eliminate interdivisional payables and receivables		
Interdivisional sales	7,500	
Interdivisional cost of goods sold		6,000
Interdivisional gross profit		1,500
To close accounts and record gross profit		
Interdivisional gross profit	600*	
Inventory		600
To eliminate unrealized interdivisional gross profit		

* *Computation of interdivisional gross profit:*

$$\text{Gross profit included in inventory} = \frac{\$1,500 \text{ profit}}{\$7,500 \text{ purchases}} = 20\%$$

$$\begin{aligned} \text{Transferred inventory still on hand} \times \text{Gross profit included in inventory} &= \$3,000 \times 20\% \\ &= \$600 \end{aligned}$$

Solved Problems

13.1 Responsibility Report. The Gifford Manufacturing Company produces cookie jars. All costs are accumulated from the responsibility centers as needed. The company's organization chart is shown in [Fig. 13-6](#). Complete the following responsibility report.

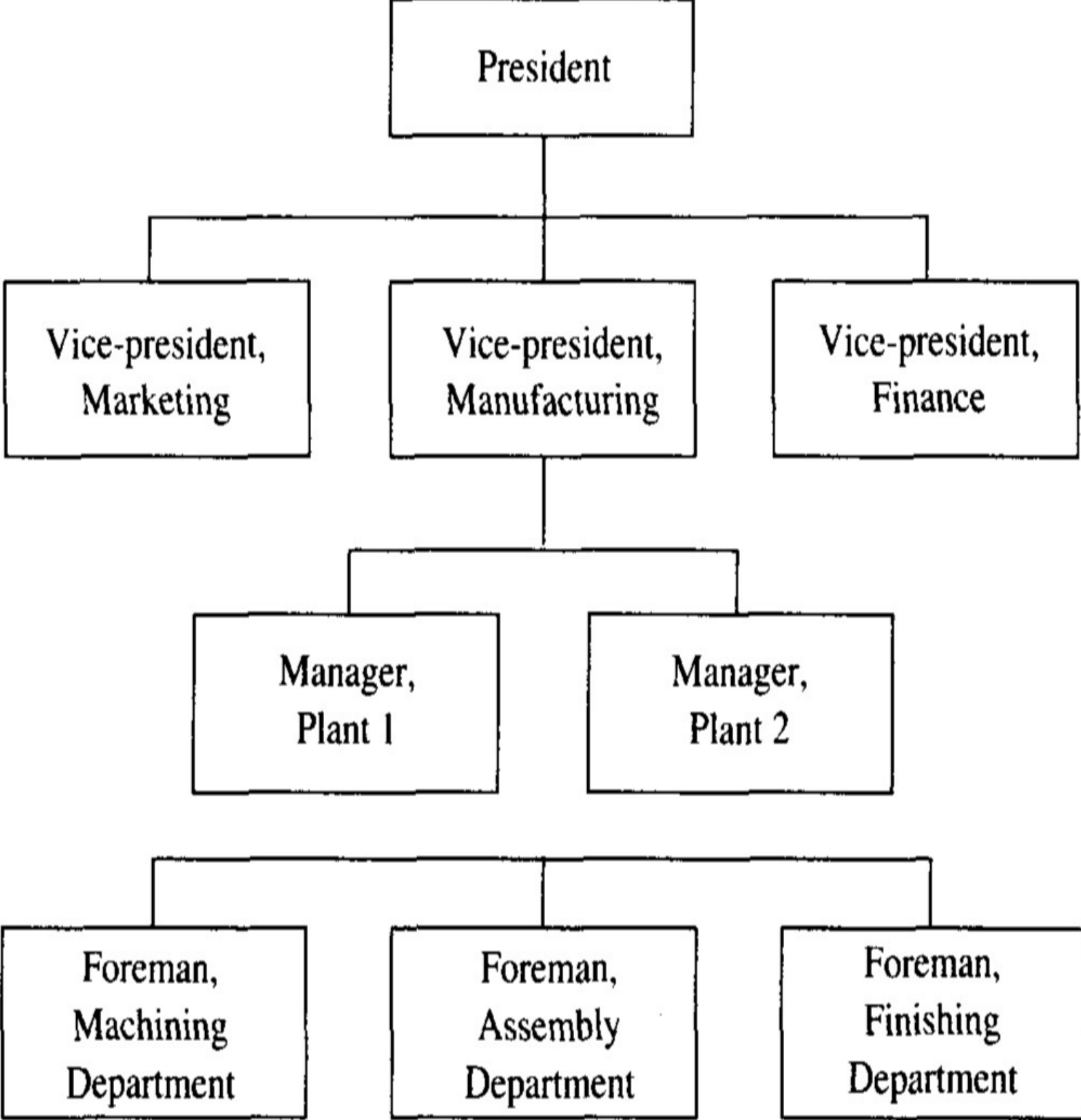


Fig. 13-6.

Responsibility Report
Month of September, 19XX

Current Month		(Favorable)
Budget	Actual	Unfavorable
		Variance

Level D: President

President's office	\$100	\$ 90	\$(10)
VP Marketing	400	(c)	50
(a)	(d)	(e)	(50)
(b)	<u>200</u>	<u>220</u>	<u>20</u>
Total controllable cost	<u><u>\$(f)</u></u>	<u><u>\$(g)</u></u>	<u><u>\$ 10</u></u>

Level C: VP Manufacturing

VP Manufacturing office	\$250	\$200	\$(50)
Plant 1	(h)	50	(50)
Plant 2	<u>150</u>	<u>200</u>	<u>50</u>
Total controllable cost	<u><u>\$500</u></u>	<u><u>\$(i)</u></u>	<u><u>\$(50)</u></u>

Level B: Manager,

Plant manager's office	\$ 75	\$ 75	\$ 0
Machining Department	(j).	(k)	(l)
Assembly Department	25	50	25
Finishing Department	<u>25</u>	<u>50</u>	<u>25</u>
Total controllable cost	<u><u>\$(m)</u></u>	<u><u>\$(n)</u></u>	<u><u>\$(o)</u></u>

Level A: Foreman, Machining Department

Direct materials	\$ 5	\$ 5	\$ 0
Direct labor	5	10	5
Machine setup	5	5	0
Rework	5	0	(5)
Supplies	<u>5</u>	<u>5</u>	<u>0</u>
Total controllable cost	<u><u>\$(p)</u></u>	<u><u>\$ 25</u></u>	<u><u>0</u></u>

SOLUTION

(a) VP Manufacturing

(b) VP Finance

(c) \$450 (\$400 + \$50)

(d) \$500 (total controllable budget cost, level C: Manufacturing)

(e) \$450 [\$500 (total controllable budget cost, level C: Manufacturing) – \$50]

(f) \$1,200

(g) \$1.210

(h) \$100 (\$500 – \$250 – \$150)

(i) \$450

(j) \$25 (\$150 (total controllable budget cost, Plant 2) – \$75 – \$25 – \$25]

(k) \$25 (\$200 (total controllable actual cost, Plant 2) – \$75 – \$50 – \$50]

(l) \$0 (\$25 – \$25)

(m) \$150 (n) \$200 (o) \$50 (p) \$25

13.2 Transfer Pricing by Market Price Method. The Gates Corporation has two decentralized divisions. Division A manufactures its product at a variable cost of \$5 per unit and a fixed cost of \$2 per unit. The product, which has a competitive market price of \$10 per unit, is transferred to Division B. The transfer price used by Gates is the competitive market price. Division B finishes the product, thereby incurring additional variable costs of \$4 per unit. Division B sells the finished product outside the company for \$16 per unit.

(a) Determine the profit for Divisions A and B and the Gates Corporation when 1,000 units are produced by Division A and transferred to Division B.

(b) In the above situation, are there any advantages in interdivisional transfers, or would purchases from, and sales to, the outside markets provide the same results?

SOLUTION

(a)	Division A	Division B	Gates Corp.
<i>Selling Price</i>			
1,000 × \$10	\$10,000		
1,000 × \$16		\$16,000	\$26,000
<i>Manufacturing</i>			
Variable costs (1,000 × \$5)	(5,000)		
Fixed costs (1,000 × \$2)	(2,000)		(7,000)
<i>Finishing</i>			
Variable costs (1,000 × \$4)		(4,000)	
Transferred-in costs (1,000 × \$10)		(10,000)	(14,000)
	<u> </u>	<u> </u>	<u> </u>
Profit	<u><u>\$ 3,000</u></u>	<u><u>\$ 2,000</u></u>	<u><u>\$ 5,000</u></u>

(b) Assuming that a perfect market exists, the profit would be the same with either interdivisional transfers or outside market transactions. Differences would probably occur in such areas as administrative and marketing expenses, reliability of market and supplier, and ease of transactions. These factors would probably make interdivisional transfers preferable for both divisions and for the Gates Corporation.

13.3 Transfer Pricing at Cost, Cost Plus, and Market Price. The Playtime Manufacturing Co. produces toy dogs in three departments, Department X manufactures the parts, Department Y does the assembling, and Department Z does the finishing. No external market exists for the unassembled parts, and Department X uses its total cost as the transfer price when transmitting the parts to Department Y. Department Y assembles the parts and uses the current market price in its transfer of goods to Department Z. The current market price for unfinished, assembled toy dogs is \$16 per unit. Department Z sells the finished toy dogs for \$22 each. The following information pertains to June, 19XX: **Department X**

Sales to Department Y	15,000 units
Variable costs	\$6 per unit
Fixed costs	\$30,000

Department Y

Sales to Department Z	15,000 units
Variable costs (added in department)	\$4 per unit
Fixed costs	\$11,250

Department Z

Sales	15,000 units
Variable costs (added in department)	\$3
Fixed costs	\$15,000

- (a) Compute the gross profit for the three divisions using Playtime Company's transfer price systems.
- (b) Which department in (a) seems to be in an unusually good position? Why?
- (c) Department X has repeatedly complained about its transfer price being based solely on total costs. The Playtime Co. is therefore changing Department X's transfer-price method from total cost to total cost plus 30%. Compute the new gross profit for X and show how it affects Departments Y and Z.

SOLUTION

(a)

Department X

Sales to Department Y (15,000 at \$8)		\$120,000
Less: Variable costs (15,000 at \$6)	\$ 90,000	
Fixed costs	<u>30,000</u>	<u>120,000</u>
Gross profit		<u><u>-0-</u></u>

Department Y

Sales to Department Z (15,000 at \$16)		\$240,000
Less: Transfer costs (15,000 at \$8)	\$120,000	
Variable costs (15,000 at \$4)	60,000	
Fixed costs	<u>11,250</u>	<u>191,250</u>
Gross profit		<u><u>\$ 48,750</u></u>

Department Z

Sales (15,000 at \$22)		\$330,000
Less: Transfer costs (\$15,000 at \$16)	\$240,000	
Variable costs (15,000 at \$3)	45,000	
Fixed costs	<u>15,000</u>	<u>300,000</u>
Gross profit		<u><u>\$ 30,000</u></u>

(b) Department Y has the best of both worlds. It is transferring in goods at cost and transferring out goods at the current market price. This accounts for its high gross profit.

(c)

Department X

Sales to Department Y (15,000 at \$10.40)		\$156,000
$\$8 + (\$8 \times 30\%) = \$10.40$		
Less: Variable costs (15,000 at \$6)	\$ 90,000	
Fixed costs	<u>30,000</u>	<u>120,000</u>
Gross profit		<u><u>\$ 36,000</u></u>

Department Y

Sales to Department Z (15,000 at \$16)		\$240,000
Less: Transfer costs (15,000 at \$10.40)	\$156,000	
Variable costs (15,000 at \$4)	60,000	
Fixed costs	<u>11,250</u>	<u>227,250</u>
Gross profit		<u><u>\$ 12,750</u></u>

Department Z would be unaffected by the change in transfer-price method.

No doubt, Department Y will now argue that the transfer price charged by X is excessive. An equitable solution might be for management to readjust the transfer price to cost plus about 20%, which would give the two departments roughly the same profit.

13.4 Journal and Elimination Entries. Use the information from part (c) of the preceding problem (Department X sold to Department Y at cost plus 30%).

- (a) Prepare the necessary journal entries to record the transactions. All interdepartmental transactions were recorded as accounts receivable, and no payments have been made. Department Z's sales were all cash transactions.

(b) Prepare all necessary elimination entries.

SOLUTION

(a) *Entries on Department X's books:*

Accounts Receivable, Department Y	\$156,000	
Interdepartmental Sales		\$156,000
Interdepartmental Cost of Goods Sold	120,000	
Inventory		120,000

Entries on Department Y's books:

Inventory	156,000	
Accounts Payable, Department X		156,000
Accounts Receivable, Department Z	240,000	
Interdepartmental Sales		240,000
Interdepartmental Cost of Goods Sold	227,250	
Inventory		227,250

Entries on Department Z's books:

Inventory	240,000	
Accounts Payable, Department Y		240,000
Cash	330,000	
Sales		330,000
Cost of Goods Sold	300,000	
Inventory		300,000

(b) Elimination entries for worksheet:

Accounts Payable, Department X	\$156,000	
Accounts Receivable, Department Y		156,000
Accounts Payable, Department Y	240,000	
Accounts Receivable, Department Z		240,000
Eliminates interdepartmental receivables and payables		
Interdepartmental Sales, Department X	\$156,000	
Interdepartmental Cost of Goods Sold		120,000
Interdepartmental Gross Profit		36,000
Interdepartmental Sales, Department Y	240,000	
Interdepartmental Cost of Goods Sold		227,250
Interdepartmental Gross Profit		12,750
To close accounts and show gross profit		

Since Department Z sold all its merchandise to outsiders, its departmental gross profit has been realized.

13.5 Five Methods of Transfer Pricing. Divisions J and T are two decentralized divisions of the Sweet Candy Company. Division J manufactures the candy, and Division T packages and distributes the candy at a sales price of \$0.15 per unit. Division J transfers 60% of its output to Division T, the remainder being sold to outside markets. The following are the expected revenues and expenses for 19XX:

	Division J	Division T
Sales	4,000,000 units	All units received from Division J
Variable costs	\$0.02 per unit	\$0.04 per unit*
Fixed costs (annual)	\$80,000	\$40,000*

* Does not include costs from Division J.

Compute the gross profit for Divisions J and T for each of the following transfer price methods: (a) Market transfer price when the market price for Division J's product is \$0.07 per unit (b) Cost transfer price (using full costs)

(c) Cost plus transfer price when the markup on total cost is 40%

(d) Negotiated transfer price when the negotiated price is \$0.06 per unit

(e) Dual transfer price based on market price and total cost

SOLUTION

(a) Market Transfer Price

Sales to outside markets (1,600,000 at \$0.07)	\$112,000	
Sales to Division T (2,400,000 at \$0.07)	<u>168,000</u>	\$280,000
Less: Variable costs (4,000,000 at \$0.02)	\$ 80,000	
Fixed costs	<u>80,000</u>	<u>160,000</u>
Gross profit		<u><u>\$120,000</u></u>

Division T

Sales (2,400,000 at \$0.15)		\$360,000
Less: Cost of units from Division J (2,400,000 at \$0.07)	\$168,000	
Other variable costs (2,400,000 at \$0.04)	96,000	
Fixed costs	<u>40,000</u>	<u>304,000</u>
Gross profit		<u><u>\$ 56,000</u></u>

(b) Cost Transfer Price

Division J

Sales to outside markets (1,600,000 at \$0.07)	\$112,000	
Sales to Division T (2,400,000 at \$0.04)*	<u>96,000</u>	\$208,000
Less: Variable costs (4,000,000 at \$0.02)	\$ 80,000	
Fixed Costs	<u>80,000</u>	<u>160,000</u>
Gross profit		<u><u>\$ 48,000</u></u>

* Calculation: Variable costs (\$0.02) + Fixed costs (\$80,000 ÷ 4,000,000) = \$0.04.

Division T

Sales (2,400,000 at \$0.15)		\$360,000
Less: Cost of units from Division J (2,400,000 at \$0.04)	\$ 96,000	
Other variable costs (2,400,000 at \$0.04)	96,000	
Fixed costs	<u>40,000</u>	<u>232,000</u>
Gross profit		<u><u>\$128,000</u></u>

(c) **Cost Plus Transfer Price**

Division J

Sales to outside markets (1,600,000 at \$0.07)	\$112,000	
Sales to Division T (2,400,000 at \$0.056)*	<u>134,400</u>	\$246,400
Less: Variable costs (4,000,000 at \$0.02)	\$ 80,000	
Fixed costs	<u>80,000</u>	<u>160,000</u>
Gross profit		<u><u>\$ 86,400</u></u>

* Calculation: Total costs (\$0.04) + Markup ($\$0.04 \times 40\% = \$0.04 + \$0.016 = \0.056).

Division T

Sales (2,400,000 at \$0.15)		\$360,000
Less: Cost of units from Division J (2,400,000 at \$0.056)	\$134,400	
Other variable costs (2,400,000 at \$0.04)	96,000	
Fixed costs	<u>40,000</u>	<u>270,400</u>
Gross profit		<u><u>\$ 89,600</u></u>

(d) Negotiated Transfer Price

Division J

Sales to outside markets (1,600,000 at \$0.07)	\$112,000	
Sales to Division T (2,400,000 at \$0.06)	<u>144,000</u>	\$256,000
Less: Variable costs (4,000,000 at \$0.02)	\$ 80,000	
Fixed costs	<u>80,000</u>	<u>160,000</u>
Gross profit		<u><u>\$ 96,000</u></u>

Division T

Sales (2,400,000 at \$0.15)		\$360,000
Less: Cost of units from Division J (2,400,000 at \$0.06)	\$144,000	
Other variable costs (2,400,000 at \$0.04)	96,000	
Fixed costs	<u>40,000</u>	<u>280,000</u>
Gross profit		<u><u>\$ 80,000</u></u>

(e) Dual Transfer Price

For goods transferred, Division J receives credit at full market price, and Division T is charged the cost transfer price.

Division J

Sales to outside markets (1,600,000 at \$0.07)	\$112,000	
Sales to Division T (2,400,000 at \$0.07)	<u>168,000</u>	\$280,000
Less: Variable costs (4,000,000 at \$0.02)	\$ 80,000	
Fixed costs	<u>80,000</u>	<u>160,000</u>
Gross profit		<u><u>\$120,000</u></u>

Division T

Sales (2,400,000 at \$0.15)		\$360,000
Less: Cost of units from Division J (2,400,000 at \$0.04)	\$ 96,000	
Other variable costs (2,400,000 at \$0.04)	96,000	
Fixed costs	<u>40,000</u>	<u>232,000</u>
Gross profit		<u><u>\$128,000</u></u>

13.6 Effects of a Change in Transfer Price. The ABC Dinghy Co. has several decentralized divisions, two of which are manufacturing and finishing. All divisions operate as profit centers and are free to buy from, and sell to, external markets. The finishing division had always purchased its intermediate goods from the manufacturing division at a price of \$225 per unit. Now the manufacturing division says it must raise its price to \$250 to cover its increased costs of \$200 per unit variable costs and \$50 per unit fixed costs. The finishing division will require 500 units.

How would the ABC Dinghy Co. be affected under the following independent circumstances?

- (a) The finishing division purchases its goods from external markets for \$235 per unit. No additional uses are found for the manufacturing division.
- (b) The finishing division purchases its goods from external markets for \$235 per unit. The manufacturing division incurs \$20,000 in cash savings to other divisions.
- (c) The finishing division purchases its goods from external markets for \$235 per unit. The manufacturing division sells 300 units of its product to outside sources for \$270 per unit.

SOLUTION

(a)

Per Unit Costs

	Finishing Division	Manufacturing Division	ABC Dinghy Company
Outside purchase	\$235	\$50*	\$285*
Transfer purchase	<u>250</u>	<u>0</u>	<u>250</u>
Savings (loss)	<u>\$ 15</u>	<u>NA</u>	<u>\$(35)</u>

* Regardless of whether or not the manufacturing division is active, it will incur fixed costs for as long as it exists. Therefore, the cost to the company for the outside purchase is the purchase price plus the manufacturing division's fixed costs.

The finishing division saves \$15 per unit (or \$17,500 for the 500-unit order) by purchasing outside, but the company loses \$35 per unit on the purchase. From the above it can be seen that the market price would have to be below \$200 per unit (\$250 total costs - \$50 fixed costs) in order for the company to benefit from an external purchase in the situation outlined.

The above is generally presented in a different format as follows:

Purchase from outsiders (500 units at \$235)	\$117,500
Less: Variable cost savings (500 units at \$200)	<u>100,000</u>
Cost to ABC Dinghy Co.	<u>\$ 17,500</u>

(b)	Purchase from outsiders (500 units at \$235)		\$117,500
	Less: Variable cost savings (500 units at \$200)	\$100,000	
	Cash savings by other divisions	<u>20,000</u>	<u>120,000</u>
	Savings to ABC Dinghy Co.		<u><u>\$ 2,500</u></u>
(c)	Sales to outsiders (300 units at \$270)	\$ 81,000	
	Less: Variable costs (300 units at \$200)	<u>60,000</u>	
	Contribution margin from outside sales		\$ 21,000
	Purchase from outsiders (500 units at \$235)	\$117,500	
	Less: Variable costs (500 units at \$200)	<u>100,000</u>	<u>17,500</u>
	Profit to ABC Dinghy Co.		<u><u>\$ 3,500</u></u>

Index

Please note that index links point to page beginnings from the print edition. Locations are approximate in e-readers, and you may need to page down one or more times after clicking a link to get to the indexed material.

- ABC plan, [26](#)
- Abnormal defective units, [59](#)
- Abnormal spoilage, [59](#), [76](#)
- Absorption costing
 - versus direct costing, [141–145](#), [152–153](#)
 - production costs under, [141](#)
- Accounting
 - for by-products, [87–91](#)
 - for joint products, [91–93](#)
 - for labor, [29–31](#)
 - for spoiled units, [76–77](#)
 - system of, for materials purchase, [18–19](#)
- Accounting rate of return, [157](#), [161](#)
- Actuaries, [28](#)
- Administrative costs, [5](#)
- Administrative expense budget, [107](#)
- Algebraic method of allocating service department costs, [46–47](#)
- Attainable standards, [117](#)
- Audit, internal, [3](#)
- Automatic order system [26](#)
- Average cost, [20](#)
- Average costing
 - and equivalent units of production, [68–69](#), [79](#), [80–83](#)
 - weighted, [68](#)
- Average inventory usage rate, [189](#)

- Balance sheet, budgeted, [109–111](#)
- Basic standards, [117](#)
- Bonus, [27](#), [36](#)
- Break-even analysis
 - contribution-margin method in, [147–148](#), [154](#), [155](#)
 - equation method in, [147](#), [155](#)
 - graphic method in, [148–150](#), [154](#)

use of, 146–147

Break-even charts, 148

Budget (*See also* Capital budget; Cash budget; Master budget)

administrative expense, 107

cost of goods sold, 105

definition of, 98

direct labor, 102

direct materials purchase, 101, 111–112

direct materials usage, 102

ending inventories, 104–105

factory overhead, 102–104, 113–114

production, 101, 111

sales, 100

selling expense, 105–106

Budget variance, 121, 136

Budgeted balance sheet, 109–111

Budgeted income statement, 107, 115

By-products

accounting for, 87–91

categories of, 87

definition of, 87

net income determination for, 95–96

profit determination for, 93–94

Capital budget, 156

accounting rate of return, 157

computation of cash flow from operations in, 160

discounted-payback method in, 159

index of profitability method in, 159

internal-rate-of-return method in, 157–158, 161

methods of evaluation in, 156

net-present-value method in, 158–159, 161

payback method in, 156

replacement chains in, 159–160

Capital costs, 6

Cash budget, 107–109, 115–116

Cash flow from operations, computation of, 160

Centralized operations, 7

Common costs, 87

Company chart, 3

Conservatism, principle of, 24

Consistency, principle of, 24
Contribution margin, 141
Contribution margin method, in bread-even analysis, 147–148, 154, 155
Control account, 36
Controller's division chart, 3
Controlling, 3
Conversion costs, 68, 678
Cost(s)
 accumulation of, 66–67
 administrative, 5
 average, 20
 capital, 6
 classification, 5–6, 11
 conversion, 68
 definition of, 4
 differential, 164–165
 direct, 5
 direct labor, 5, 40
 direct material, 5, 40
 factory overhead, 5, 66–67
 financial, 5
 fixed, 6, 7, 11, 14–15, 39, 148
 historical, 165
 incremental, 164–165
 indirect, 5, 39
 irrelevant, 164
 job order, 6
 joint, 87, 167
 joint product, 91
 labor, 26
 manufacturing, 5
 marketing, 5
 opportunity, 165–166, 178
 period, 5
 process, 6
 product, 5
 production, 5
 relevant, 164
 revenue, 6
 semivariable, 7, 39
 separable, 167

- service, 5
- sunk, 165
- total, 6
- total acquisition, 187
- total carrying, 187
- total ordering, 187
- unit, 6–7
- variable, 5, 7, 11, 14–15, 39, 148–150

Cost accounting

- definition of, 4
- nature of, 4–5
- role of, 1–8
- uses of, 1

Cost center, 202

Cost department, 4

Cost elements, 5, 11

Cost method, in transfer pricing, 207, 213–215, 217

Cost of goods manufactured, 7–8, 15–17

Cost of goods sold budget, 105, 114–115

Cost of materials issued, 22, 23, 31–33

Cost of production report, 70–73, 75–76, 80–83

- costs accounted for section, 70

- costs to account for section, 70

- equivalent production section, 70

- quantities section, 70

Cost plus method, in transfer pricing, 207, 213–215, 217

Cost systems, 6

Cost variance, 129, 138, 140

Cost-volume-profit planning, 151, 155

- adjustment for income taxes in, 151

- risk and profit analysis in, 152

- use of, 151

Critical path, 184–185, 193–194

Decentralized operations

- advantages and disadvantages of, 9, 201–202

- concepts of organization in, 198

- functional approach to, 198–199

- geographic approach to, 200–201

- product approach to, 199–200

Decision theory

definition of, 181

economic order quantity (EOQ) in, 186–189, 194–195

elements in developing model in, 181

general approach to uncertainty in, 181–182

inventory costs and control in, 186–187

inventory order point in, 189–190

inventory stockouts and uncertainty in, 191–192

program evaluation and review technique (PERT) and uncertainty in, 184–186, 193–194

project proposals and uncertainty in, 182–184, 193

safety stock in, 190–191, 196–197

Defective units, 58

Departmental transfers, 67

Differential costs, 164–165

Direct costing

versus absorption costing, 141–145, 152–153

adjustment for income taxes, 151

advantages of, 146

contribution margin method in, 147–148

definition of, 141

disadvantages of, 146

equation method in, 147

graphic method in, 148–150

product and period costs in, 141

production costs under, 141

risk and profit analysis in, 152

use of, 145

Direct costs, 5

Direct labor, 5, 18

in job order costs system 58

Direct labor budget, 102, 112

Direct labor costs, 5, 40

in process cost system, 66

Direct labor efficiency standard, 118

Direct labor efficiency variance, 121

computation of, 124, 135

Direct labor hours, 40

Direct labor price standard, 118

Direct labor price variance, 120–121

computation of, 124, 135

Direct labor standards, 118

Direct materials, 5, 18

- in job order costs system, 58
- Direct materials costs, 5, 40
 - in process cost system, 66
- Direct materials efficiency standard, 117
- Direct materials efficiency variance, 120
 - computation of, 123, 135
- Direct materials price standard, 117
- Direct materials price variance, 120
 - computation of, 123, 135
- Direct materials purchase budget, 101, 111–112
- Direct materials standards, 117
- Direct materials usage budget, 102, 112
- Direct method of allocating service department costs, 43–45
- Discounted-payback method, in capital budgeting, 159, 162
- Divisional evaluation, in performance measurement, 175, 178–180
- Dual prices method, in transfer pricing, 209, 218

- Earnings center, 202
- Earnings ratio, 174
- Economic order quantity (EOQ)
 - in decision theory, 186–189, 194–195
 - determination of, 187–189
- Efficiency variance, 122, 126, 134, 136, 137
- Ending inventories budget, 104–105
- Ending materials inventory, 19–24, 31–33, 34
- Equation method
 - in break-even analysis, 147, 155
 - of inventory order point, 190
- Equivalent units of production, 68–70, 79, 80–83
- Expected actual or short-run capacity, 41
- Expected value, 182–183
- Expense, definition of, 5
- Expense center, 202

- Factory ledger, 47
- Factory overhead
 - activity level to be used, 41
 - allocation of service department costs to producing departments, 43–47, 49–53
 - applied, 39
 - base to be used in, 39–40

budget for, [102–104](#), [113–114](#)

costs of, [5](#), [66–67](#)

definition of, [5](#), [39](#)

over-or underapplied, [42–43](#), [49](#)

in job order costs system, [58](#)

journal entries for, [41–42](#), [48–54](#)

rate, [39–41](#), [48](#), [64](#)

standards, [118](#)

variances, [121–122](#), [124–126](#), [135](#), [136–137](#)

Federal Insurance Contribution Act (FICA), [28](#)

Federal Unemployment Tax Act (FUTA), [29](#)

FIFO (first-in, first-out)

costing, [68–69](#), [80](#), [83–86](#)

inventory system under, [19](#), [22](#), [32–33](#)

Financial costs, [5](#)

Fixed costs, [6](#), [7](#), [11](#), [14–15](#), [39](#), [148](#)

for special orders, [169](#)

Fixed standards, [117](#)

Flow of units, in process cost system, [67–68](#), [78](#)

Formula method, in determining economic order quantity, [188](#)

Fringe costs, [28](#)

Graphic method

in break-even analysis, [148–150](#), [154](#)

in determining economic order quantity, [188](#)

in determining safety stock, [191](#)

Graphic presentation, of inventory order point, [190](#)

Gross earnings, [26](#)

Gross marginal income, [141](#)

Gross profit, [141](#)

change in, [129–130](#)

Gross profit analysis, [129](#), [138–140](#)

Historical costs, [165](#)

Holiday pay, [27–28](#)

Hours

direct labor, [40](#)

machine, [40](#)

Ideal standards, [117](#)

- Imputed-interest rate, [176](#)
- Incentive plans, [29](#)
- Income statements, [7–8](#), [13–14](#)
 - budgeted, [107](#)
 - preparation under direct costing versus absorption costing, [141–145](#)
- Incremental analysis, [168–169](#), [177–178](#)
- Incremental costs, [164–165](#)
 - in transfer pricing, [209–210](#)
- Index of profitability method, in capital budgeting, [159](#), [162](#)
- Indirect costs, [5](#), [39](#)
- Indirect labor, [18](#)
- Indirect materials, [18](#)
- Inspection time, [119](#)
- Interdivisional profit, [210](#)
- Internal audit, [3](#)
- Internal-rate-of-return method (IRR), in capital budgeting, [157–158](#), [161](#)
- Interplant profit, [210](#)
- Intracompany profit, [210](#)
- Inventories
 - control procedures in, [25–26](#)
 - costing materials issued and ending materials, [19–24](#), [31–33](#), [34](#)
 - ending budget, [104–105](#)
 - work-in-process, [7](#), [19](#)
- Inventory costs, [141](#)
 - in decision theory, [186–187](#)
 - under direct versus absorption costing, [141](#)
- Inventory methods, comparison of, [24](#)
- Inventory order point, [189–190](#)
- Inventory stockouts and uncertainty, [191–192](#)
- Investment center, [203](#)
- Investment turnover, [173](#), [174](#)
- Irrelevant costs, [164](#)

- Job order cost, [6](#)
- Job order cost system [55–56](#)
 - defective units in, [58–59](#), [64](#)
 - elements of cost in, [55](#)
 - establishing standards in, [118–119](#)
 - job order cost sheet for, [58](#), [61](#)
 - journal entries for, [56–57](#), [59–60](#)
 - profit or loss on jobs, [62–63](#)

spoiled units in, 58–59, 64

Joint costs, 87, 167

allocation of, 96–97

definition of, 87

Joint products, 168

accounting for, 91–93

basic characteristics of, 91

costs of, 91

definition of, 91

Journal entries

in cost of production report, 74

for factory overhead, 41–42

for job order cost system, 56–57

in standard cost system, 126–128

Just-in-time philosophy, 119–120

Labor

accounting for, 29–31

bonus, 27

characteristics of, 18

costs of, 26

direct, 18, 58, 118

direct budget for, 102, 112

fringe costs, 28–29

indirect, 18

overtime premium, 26–27

pensions, 28

shift premium or differential, 27

vacation and holiday pay, 27–28

Labor job ticket, 29–30

Lead time, 189

Ledgers, factory, 47

LIFO (last-in, first-out), 19, 23, 32–33, 34

Line and staff responsibility, 4

Line function, 4

Long-run capacity, 41

Loss, definition of, 5

Lower of cost or market (LCM rule), 25–25, 34–35

Machine hours, 40

- Main product, 87
- Make-or-buy decisions, 170–172, 178
- Managerial functions, 1, 3, 9–11
- Manufacturing costs, 5
- Marginal income, 141
- Marketing costs, 5
- Market price method, in transfer pricing, 208–209, 213–215, 216–217
- Market value at split-off point method, for joint products accounting, 91
- Master budget
 - administrative expense budget in, 107
 - budgeted balance sheet in, 109–111
 - budgeted income statement in, 107, 115
 - cash budget in, 107–109, 115–116
 - cost of goods sold budget in, 105, 114–115
 - developing, 98–100
 - direct labor budget in, 102, 112
 - direct materials purchase budget in, 101, 111–112
 - direct materials usage budget in, 102, 112
 - ending inventories budget in, 104–105
 - factory overhead budget in, 102–104, 113–114
 - grass roots approach to, 98
 - nature of, 98
 - production budget in, 101, 111
 - sales budget in, 100
 - selling expense budget in, 105–106
- Material requisition, 19
- Materials
 - characteristics of, 18
 - costing issued, and ending materials inventory, 19–24, 31–33, 34
 - direct, 18, 58, 117
 - direct purchase budget for, 101
 - direct usage budget for, 102
 - indirect, 18
 - issuance of, 19
 - costing of, 22, 23, 31–33
 - second department and introduction of additional, 74–75
 - systems of accounting for purchase of, 18–19
- Min-max method, 25, 26
- Mix variance, 131
- Moving time, 119
- Multiproducts, 130–133, 138–140

Negotiated price method, in transfer pricing, 209, 217–218

Net operating profit (NOP), 142

Net-present-value method (NVP), in capital budgeting, 158–159, 161

Net realizable value method, 88

- for joint products accounting, 92

Nonproductive pay, 27

Nonvalue-added time, 119

Normal capacity, 41

Normal defective units, 59

Normal spoilage, 58–59, 76, 86

One-factor analysis, of factory overhead variance, 121, 124–126

Opportunity costs, 165–166, 178

Order cycling, 25

Order point, 189

Organization charts, 3, 10–11

Organizational planning, 198–200

Overhead (*see* Factory overhead)

Overtime premium, 26

Payback method, in capital budgeting, 156, 161

Payroll, accounting for, 30, 35–38

Pensions, 28

Performance measurement

- approaches to, 173
- divisional evaluation in, 175, 178–179
- residual income in, 176
- return on investment in, 173, 174
- return-on-investment ratio in, 173–174, 178–180
- total company evaluation in, 174–175

Performance reports, 203–205

- essentials of good, 205–206

Period costs, 5

Periodic cost accumulation systems, 6, 38

Periodic inventory system, 18, 20, 21

- costing of materials under, 19–24, 31–32

Perpetual cost accumulation systems, 6, 36

Perpetual inventory system, 18

- costing of materials under, 19–24, 32–33, 34

Physical output method, for joint products accounting, 92–93

Price, unit, [20](#)

Price variance, [122](#), [125](#), [134](#), [136](#)

Process cost, [6](#)

Process cost system

- accounting for spoiled units in, [76](#)
- accumulation of costs in, [66–67](#)
- cost of production report in, [70–73](#), [75–76](#), [80–83](#)
- departmental transfers in, [67](#)
- equivalent units of production in, [67–70](#), [79–80](#)
- establishing standards in, [118–119](#)
- flow of units in, [67–68](#), [78](#)
- and introduction of additional materials, [74–75](#)
- journal entries in, [74](#)
- second department in, [75–76](#)
- spoiled units (goods), [76](#), [86](#)

Processing time, [119](#)

Producing department

- allocation of service department costs to, [43–47](#)
- definition of, [43](#)

Product costs, [5](#)

Production, equivalent units of, in process cost system, [68–70](#), [79–80](#)

Production budget, [101](#), [111](#)

Production costs, [5](#)

Production volume variance, [121](#), [122](#), [125](#), [126](#), [134](#), [136](#), [137](#)

Product mix decision, in relevant costing, [172](#)

Profit

- interdivisional, [210](#)
- interplant, [210](#)
- intracompany, [210](#)

Profit center, [202](#)

Profit planning, and use of direct costing, [145](#)

Program evaluation and review technique (PERT) and uncertainty, [184–186](#), [193–194](#)

Project proposals, and uncertainty, [182–184](#)

Purchase budget, direct materials, [101](#), [111–112](#)

Pure volume variance, [130](#), [139](#)

Quality control, [119](#)

Queue time, [119](#)

Relevant costing

in decision making, 164

differential or incremental costs in, 164–165

discontinuing segment in, 167–168, 176–177

opportunity costs in, 165–166, 178

relevant versus irrelevant costs in, 164

segment analysis in, 167

sunk costs in, 165

further selling or processing in, 168–169, 177

make-or-buy decisions in, 170–172, 178

performance measurement by, 173–176, 178–180

product mix decision in, 172

special orders in, 169–170, 177–178

Relevant costs, 164

Relevant range, 148

Replacement chains, in capital budgeting, 159–160

Residual income, 176

Responsibility, managerial, 1, 3, 9–11

Responsibility accounting

essentials of control in, 203

nature of, 202

responsibility centers in, 202–203

Responsibility accounting reports, 203–205, 211–212

essentials of, 205–206

Responsibility centers, in responsibility accounting, 202–203

Return on investment (ROI)

advantages and disadvantages of, 174

in performance measurement, 173–174, 178–180

Revenue costs, 6

Reversal cost method, 88

Risk and profit analysis, in cost-volume-profit planning, 152

Safety stock, 190–191, 196–197

Salaries, 26

Sales budget, 100

Sales forecast, 100

Sales price variance, 129, 138

Second department, 74–76

Segmental analysis, 167–168, 176–177

Selling expense budget, 105–106

Semivariable costs, 7, 39

Separable costs, 167

Service costs, [5](#)

Service department

- allocation of costs, to producing departments, [43–47](#)
- definition of, [43](#)

Shift premium or differential, [27](#)

Simple average, [20](#)

Simple moving average, [20–21](#)

Social Security Act, [28](#)

Special orders, in relevant costing, [169–170](#), [177–178](#)

Split-off point, [87](#), [168](#), [177](#)

Spoiled units, [58](#), [76](#)

- abnormal, [59](#), [76](#)
- accounting for, [76–77](#)
- normal, [58–59](#), [76](#), [86](#)

Staff function, [4](#)

Standard costs, [117](#)

Standard cost system, journal entries in, [126–128](#)

Standard deviation, [183–184](#), [193](#)

Standards

- establishing, in process and job order cost systems, [118–119](#)
- establishment of, [117](#)
- types of, [117](#)

State Unemployment Tax Act (SUTA), [29](#)

State Workers' Compensation, [29](#)

Step method of allocating service department costs, [45–46](#)

Storage time, [119](#)

Subsidiary ledger, [36](#)

Sunk costs, [165](#)

Tabular method, in determining economic order quantity, [187–189](#)

Three-factor analysis, of factory overhead variances, [122](#), [125–126](#)

Throughput time, [119](#)

Time card, [29](#)

Timekeeping, [29–30](#)

Total acquisition costs, [187](#)

Total carrying costs, [187](#)

Total company evaluation in performance measurement, [174–175](#)

Total costs, [6](#)

Total ordering costs, [187](#)

Transfer pricing, [202](#), [206](#)

- accounting entries in, [210–211](#), [215–216](#)

cost method in, 207, 213–215, 217

cost plus method in, 207, 213–215, 217

dual prices method in, 209, 218

incremental costs method in, 209–210

market price method in, 208–209, 213–215, 216–217

negotiated price method in, 209, 217–218

objectives of, 206

significance of, 206

Two-bin method, 25, 26

Two-factor analysis, of factory overhead variances, 121, 125

Uncertainty

general approach to, in decision theory, 181–182

and inventory stockouts, 191–192

and Program Evaluation and Review Technique, 184–186

and project proposals, 182–184

Unit costs, 6

Unit price, 20

Units of production, 39

Usage budget, direct materials, 102, 112

Vacation pay, 27–28, 36–37

Value-added time, 119

Variable costs, 5, 7, 11, 14–15, 39, 148–150

Variance

computation of, 123–126

cost, 129, 138, 140

disposition of, 128

mix, 131

proration of, 128

pure volume, 130

sales price, 129

volume, 129, 138

Variance analysis, 120–123, 133–137

Volume variance, 129, 138

Wages, 26

Waiting time, 119

Waste time, 119

Weighted average costing, 19, 21, 32–33, 68

Work-in-process inventory account, [7](#), [19](#)

Zero defect program, [119](#)

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