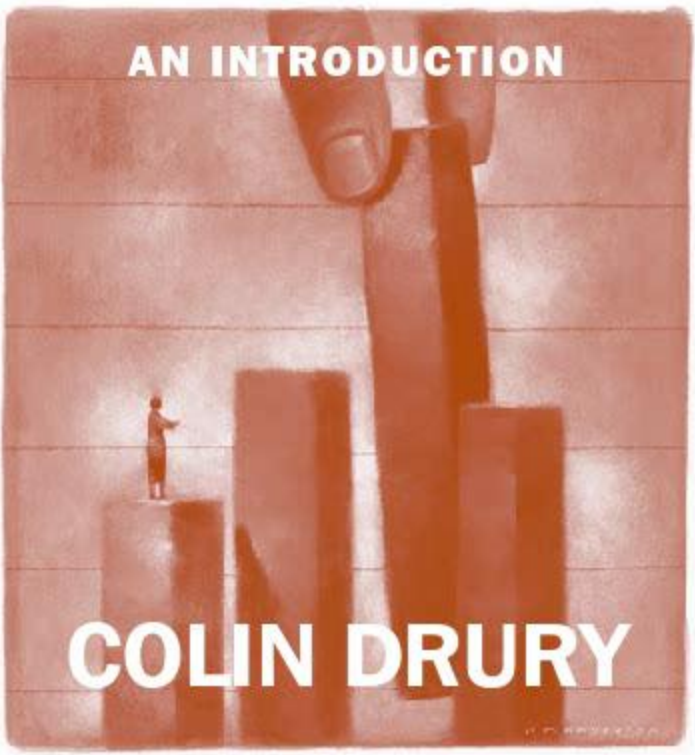
SIXTH EDITION

COST and MANAGEMENT ACCOUNTING

AN INTRODUCTION



COLIN DRURY

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Colin Drury

Publishing Director
John Yates

Publisher
Patrick Bond

Development Manager
Anna Carter

Production Editor
Alison Chappell

Manufacturing Manager
Helen Mason

Marketing Manager
Katie Thorn

Typesetter
Saxon Graphics, Derby

Production Controller
Maeve Healy

Cover Design
Design Deluxe, Bath, UK

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For more information, contact
Thomson Learning,
High Holborn House;
50-51 Bedford Row,
London WC1R 4LR

or visit us on the World Wide Web at:
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PREFACE AND ACKNOWLEDGEMENTS



The aim of the sixth edition of this book is to provide an introduction to the theory and practice of cost and management accounting. A cost accounting system is concerned with accumulating costs for inventory valuation to meet external financial accounting and internal monthly or quarterly profit measurement requirements. A management accounting system accumulates, classifies, summarizes and reports information that will assist employees within an organization in their decision-making, planning, control and performance measurement activities. This book is concerned with both cost and management accounting, with similar emphasis being placed on both systems.

Intended primarily for students who are pursuing a one-year cost and management accounting course, the book is ideal for those approaching this subject for the first time. The more advanced topics contained in the final stages of the cost and management accounting syllabuses of the professional accountancy bodies and final year degree courses are not included. These topics are included in the author's successful *Management and Cost Accounting*, the sixth edition of which is also published by Thomson Learning.

Feedback from teachers in a large number of universities indicated that they had found the content, structure and presentation of *Management and Cost Accounting* extremely satisfactory and most appropriate for students pursuing a two-year management accounting course at an advanced professional or degree level. They also indicated that there was a need for a book (based on *Management and Cost Accounting*) tailored to meet the requirements of a one-year introductory course in cost and management accounting. Many lecturers, in particular those running introductory courses, felt there was a need for an introductory text which covered the required ground in an academically sound manner and which was also appropriate for students on non-advanced courses. This book is aimed specifically at students who are pursuing a one-year non-advanced cost and management accountancy course and is particularly suitable for the following courses:

- Foundation/intermediate professional accountancy (e.g. Chartered Association of Certified Accountants, Chartered Institute of Management Accountants and one-year college foundation courses).
- Association of Accounting Technicians.
- Higher National Certificate and Diploma in business and finance.
- A first-level course for undergraduate accounting and finance or business students.

An introductory course in financial accounting is not a prerequisite, although many students will have undertaken such a course. The flexibility provided by modular courses can result in introductory classes consisting of a group of students not studying management accounting beyond an intermediate level and a further group continuing their studies beyond the intermediate level. *Cost and Management*

Accounting: An Introduction is appropriate for the former group and *Management and Cost Accounting* can be adopted by the latter. Because much of the content (and most of the examples and questions) in *Cost and Management Accounting: An Introduction* have been extracted from *Management and Cost Accounting*, lecturers can assign identical reading and questions and also recommend two separate books that are geared to the specific requirements of the students.

Structure and plan of the book

In writing this book I have adopted the same structure as that in *Management and Cost Accounting*. The major theme is that different financial information is required for different purposes. The framework is based on the principle that there are three ways of constructing accounting information. The first is cost accounting with its emphasis on producing product costs for allocating costs between cost of goods sold and inventories to meet external and internal financial accounting inventory valuation and profit measurement requirements. The second is the notion of decision-relevant costs with the emphasis on providing information to help managers to make good decisions. The third is responsibility accounting and performance measurement which focuses on both financial and non-financial information, in particular the assignment of costs and revenues to responsibility centres.

This book has 18 chapters divided into four parts. The first part (Part One) consists of two chapters and provides an introduction to cost and management accounting and a framework for studying the remaining chapters. The following three parts reflect the three different ways of constructing accounting information. Part Two consists of six chapters and is entitled 'Cost Accumulation for Inventory Valuation and Profit Measurement'. This section focuses mainly on assigning costs to products to separate the costs incurred during a period between costs of goods sold and the closing inventory valuation for internal and external profit measurement. The extent to which product costs accumulated for inventory valuation and profit measurement should be adjusted for meeting decision-making, cost control and performance measurement requirements is also considered briefly. Part Three consists of seven chapters and is entitled 'Information for Decision-making'. Here the focus is on measuring and identifying those costs which are relevant for different types of decisions. The title of Part Four is 'Information for Planning, Control and Performance Measurement'. It consists of three chapters and concentrates on the process of translating goals and objectives into specific activities and the resources that are required, via the short-term (budgeting) and long-term planning processes, to achieve the goals and objectives. In addition, the management control systems that organizations use are described and the role that management accounting control systems play within the overall control process is examined. The emphasis here is on the accounting process as a means of providing information to help managers control the activities for which they are responsible.

In devising a framework around the three methods of constructing financial information there is a risk that the student will not appreciate that the three categories use many common elements, that they overlap, and that they constitute a single overall management accounting system, rather than three independent systems. I have taken steps to minimize this risk in each section by emphasizing why financial information for one purpose should or should not be adjusted for another purpose. In short, each section of the book is not presented in isolation and an integrative approach has been taken.

Major changes in the content of the sixth edition

To accommodate the enormous changes that occurred in the theory and practice of management accounting during the 1990s the previous edition incorporated the most extensive rewrite of the text since the book was first published. Although significant changes in the content have been made to the sixth edition the major focus has been on pedagogical changes. The most notable alterations are:

1. New text has been added to Chapter 1 relating to the impact of information technology and the international convergence of management accounting practices.
2. Recently, some of the professional accountancy examination bodies have introduced aspects relating to areas that have previously been classified as advanced topics. To accommodate these changes three new chapters have been added – Chapter 10 (Cost estimation and cost behaviour), Chapter 12 (The application of linear programming to management accounting) and Chapter 14 (Decision-making under conditions of risk and uncertainty).
3. The introduction of illustrative boxed examples (entitled 'Real World Views') throughout the text highlighting the practical application of management accounting concepts and techniques by real companies operating in a range of industry sectors in various countries throughout the world.
4. The end-of-chapter summaries for all of the chapters have been rewritten and replaced with a comprehensive summary of the learning objectives listed at the beginning of each chapter. This will enable readers to test their knowledge of key concepts and evaluate their ability to achieve chapter learning objectives.
5. Revision of end-of-chapter assessment material. The assessment material consists of review questions and review problems. The review questions are short introductory questions that enable readers to assess their understanding of the main topics included in the text. Each question is followed by page numbers within parentheses that indicate where in the text the answers to specific questions can be found. The review problems are more complex and require readers to relate and apply the chapter content to various business problems. The review problems normally begin with multiple-choice problems that generally take about 10 minutes to complete. The remaining problems are more time-consuming and generally progress according to their level of difficulty. Previous editions of the book contained end-of-chapter questions where answers were only available in the *Students' Manual* accompanying this book. These questions have now been removed from the text and incorporated in the *Students' Manual*. This manual (containing both questions and answers) is now provided free on the accompanying website www.drury-online.com.
6. Previous editions of the book contained end-of-chapter questions where the answers were only available to lecturers in the *Instructors' Manual* accompanying this book. These questions have now been removed from the text and are available for students and lecturers to access on the accompanying website www.drury-online.com. Solutions to the questions are only available to lecturers on the lecturer's password-protected section of the website. The questions and answers are also contained in the instructors' manual that is available in print format, free to adopting lecturers.
7. The introduction of case studies. The final section of this book includes a list of over 20 case studies that are available on the dedicated website for this book. Both lecturers and students can download these case studies from the open

access section of the website. Teaching notes for the case studies can be downloaded only by lecturers from the password-protected lecturer's section of the website. The cases generally cover the content of several chapters and contain questions to which there is no ideal answer. They are intended to encourage independent thought and initiative and to relate and apply your understanding of the content of this book in more uncertain situations. They are also intended to develop your critical thinking and analytical skills.

HIGHLIGHTING OF ADVANCED READING SECTIONS

Some of the professional accountancy examination bodies have introduced aspects relating to areas that have previously been classified as advanced topics. Many readers, however, will not require a comprehensive treatment of all of the topics that are contained in the book. To meet the different requirements of the readers, the more advanced material that is not essential for those readers not requiring an in-depth knowledge of a particular topic has been highlighted. The start of each advanced reading section is marked with a symbol and a vertical line is used to highlight the full section. You should check your course content to ascertain if you will need to read the highlighted advanced reading sections.

INTERNATIONAL FOCUS

The book has now become an established text in many different countries throughout the world. Because of this a more international focus has been adopted. A major feature is the presentation of boxed exhibits of surveys and practical applications of management accounting in companies in many different countries, particularly the European mainland. To simplify the presentation, however, the UK pound monetary unit has mostly been used throughout the book. Most of the assessment material has incorporated questions set by the UK professional accountancy bodies. These questions are, however, appropriate for worldwide use.

ASSESSMENT MATERIAL

Throughout this book simple illustrations have been provided. You can check your understanding of each chapter by answering the review questions. Each question is followed by page numbers within parentheses that indicate where in the text the answers to specific questions can be found. More complex review problems are also set at the end of each chapter to enable students to pursue certain topics in more depth. Fully worked solutions to the review problems are provided in a separate section at the end of the book.

This book is part of an integrated educational package. A *Students' Manual* that includes additional review problems and accompanying answers is available free to download from the accompanying website. Additional review problems and case studies are available for students and lecturers to access on the accompanying website www.drury-online.com. Solutions to the review problems and case study teaching notes are only available to lecturers on the lecturer's password-protected section of the website. The review problems and answers are also contained in the *Instructors' Manual* that is available in print format, free to adopting lecturers.

A testbank of questions accompanies this text which allows lecturers to create online, paper and local area network (LAN) tests. This CD-based product is only available through your Thomson sales representative.

In recognition of the increasing need for the integration of IT teaching into the curriculum, this book is accompanied by an online *Spreadsheet Applications Manual*, which has been written by Dr Alicia Gazely of Nottingham Business School. This explains basic spreadsheet techniques and then builds up ten spreadsheet models which illustrate, and allow students to explore, examples in the main text. The spreadsheets, guidance notes and online access are available to teachers on adoption. Further details of this package are given in the section covering the Dedicated Web-site below.

SUPPLEMENTARY MATERIAL

DEDICATED WEBSITE

The dedicated website can be found at www.drury-online.com The lecturer section is password-protected and the password is available free to lecturers who confirm their adoption of the sixth edition – lecturers should complete the registration form on the website to apply for their password, which will then be sent to them by e-mail.

The following range of material is available:

FOR STUDENTS AND LECTURERS (OPEN ACCESS):

CASE STUDIES
Internationally focused case studies. (NB Teaching notes to accompany the cases are available in the password-protected lecturer area of the site.)

MCQ'S *(compiled by Colin Drury and Wayne Fiddler)*
Interactive multiple choice questions to accompany each chapter. The student takes the test online to check their grasp of the key points in each chapter. Detailed feedback is provided for each question if the student chooses the wrong answer.

LINKS TO ACCOUNTING AND FINANCE SITES ON THE WEB
Including links to the main accounting firms, accounting magazines and journals and careers and job search pages.

STUDENTS MANUAL
The *Students' Manual* is now provided free from the site in PDF (Portable Document Format), the *Students' Manual* contains further questions for students which are accompanied by the supporting answers.

Extra review problems are provided, solutions to these appear in the *Instructor's Manual* on the lecturer's password-protected section of the website.

FOR LECTURERS ONLY (PASSWORD PROTECTED)

INSTRUCTORS' MANUAL
Available to download free from the site in PDF (Portable Document Format), the manual includes answers to the additional questions on the open access website.

TEACHING NOTES TO THE CASE STUDIES
To accompany the case studies available in the student area of the website.

SPREADSHEET EXERCISES *(compiled and designed by Alicia Gazely of Nottingham Trent University)*
Created in Excel to accompany the self assessment exercises in the book, the exercises can be saved by the lecturer to their own directories and distributed to students as each topic is covered. Each exercise explains a basic spreadsheet technique which illustrates, and allows the student to explore, examples in the main text.

POWERPOINT (TM) SLIDES
Powerpoint presentations to accompany each chapter.

OVERHEAD TRANSPARENCIES
Available to download as pdf files.

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wife, Bronwen, for converting the original manuscript of the earlier editions into final type-written form and for her continued help and support throughout the six editions of this book.

WALK THROUGH TOUR



Learning Objectives Listed at the start of each chapter, highlighting the core coverage that you should acquire after studying each chapter.



Exhibits Illustrations of accounting techniques and information are presented throughout the text.



Examples Worked accounting examples are shown throughout the text.



Key Terms and Concepts Highlighted throughout the text where they first appear alerting the student to the core concepts and techniques. Also listed at the end of each chapter with page references.



Real World View Real-world cases are provided throughout the text, they help to demonstrate the theory in practice and practical application of accounting in real companies internationally.



Advanced Reading The more advanced material that is not essential for those readers not requiring an in-depth knowledge of a topic has been highlighted. These should be read when you have fully understood the remaining content of the chapter.



Summary Bulleted list at the end of each chapter reviewing briefly the main concepts and key points covered in each chapter, linked back to the Learning Objectives.



Key Examination Points Important examination tips are presented at the end of each chapter. They show the main concepts to be learnt from the chapter when studying for your examinations.



Review Questions Review questions allow revision of the main issues and concepts learnt within the chapter. Page numbers next to the questions show where the answers can be found.



Review Problems Review problems allow you to relate and apply the chapter content to various business problems. Fully worked solutions are found in the back of the text.

ABOUT THE WEBSITE



A Companion website accompanies

COST and MANAGEMENT ACCOUNTING

AN INTRODUCTION, SIXTH EDITION

COLIN DRURY

Visit the *Cost and Management Accounting 6/e* accompanying website at www.drury-online.com to find further teaching and learning material including:

For Students

- Multiple choice questions for each chapter
- Case studies with accompanying questions
- Related weblinks
- Instructor questions – answers are provided on the lecturers side of the site
- *Students' Manual* – including additional questions and accompanying answers, now available free to download from the website

For Lecturers

- *Instructors' Manual* – including model anwers to Instructor questions found on the students' side of the site
- Downloadable PowerPoint slides
- Case Study Teaching Notes to accompany the case studies on the website and within the text
- Spreadsheet models to accompany exercises within the text. The models incorporate a range of spreadsheet techniques which are explained in text notes adjacent to the calculations

Supplementary resources

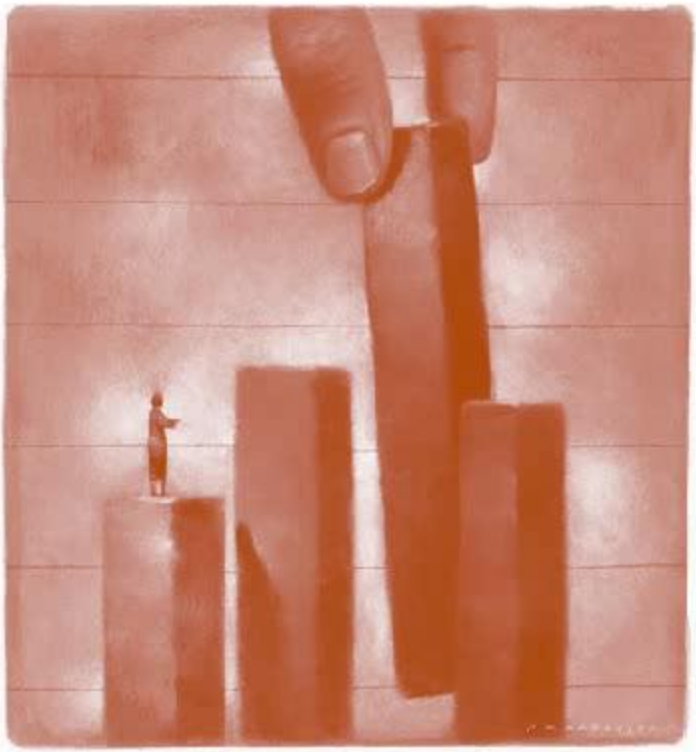
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COST and MANAGEMENT ACCOUNTING



PART 1

Introduction to Management and Cost Accounting

1 Introduction to management accounting

2 An introduction to cost terms and concepts

The objective of this section is to provide an introduction to cost and management accounting. In Chapter 1 we define accounting and distinguish between financial, management and cost accounting. This is followed by an examination of the role of management accounting in providing information to managers for decision-making, planning, control and performance measurement. In addition, the important changes that are taking place in the business environment are considered. Progression through the book will reveal how these changes are influencing management accounting systems. In Chapter 2 the basic cost terms and concepts that are used in the cost and management accounting literature are described.



Introduction to management accounting

1

There are many definitions of accounting, but the one that captures the theme of this book is the definition formulated by the American Accounting Association. It describes accounting as

the process of identifying, measuring and communicating economic information to permit informed judgements and decisions by users of the information.

In other words, accounting is concerned with providing both financial and non-financial information that will help decision-makers to make good decisions. An understanding of accounting therefore requires an understanding of the decision-making process and an awareness of the users of accounting information.

During the past two decades many organizations in both the manufacturing and service sectors have faced dramatic changes in their business environment. Deregulation combined with extensive competition from overseas companies in domestic markets has resulted in a situation where most companies are now competing in a highly competitive global market. At the same time there has been a significant reduction in product life cycles arising from technological innovations and

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- distinguish between management accounting and financial accounting;
- identify and describe the elements involved in the decision-making, planning and control process;
- justify the view that a major objective of commercial organizations is to broadly seek to maximize the present value of future cash flows;
- explain the factors that have influenced the changes in the competitive environment;
- outline and describe the key success factors that directly affect customer satisfaction;
- identify and describe the functions of a management accounting system.

the need to meet increasingly discriminating customer demands. To compete successfully in today's highly competitive global environment companies have made customer satisfaction an overriding priority. They have also adopted new management approaches, changed their manufacturing systems and invested in new technologies. These changes have had a significant influence on management accounting systems. Progression through the book will reveal how these changes have influenced cost and management accounting systems, but first of all it is important that you have a good background knowledge of some of the important changes that have occurred in the business environment. This chapter aims to provide such knowledge.

The objective of this first chapter is to provide the background knowledge that will enable you to achieve a more meaningful insight into the issues and problems of cost and management accounting that are discussed in the book. We begin by looking at the users of accounting information and identifying their requirements. This is followed by a description of the decision-making process and the changing business and manufacturing environment. Finally, the different functions of management accounting are described.

The users of accounting information

Accounting is a language that communicates economic information to people who have an interest in an organization – managers, shareholders and potential investors, employees, creditors and the government. Managers require information that will assist them in their decision-making and control activities; for example, information is needed on the estimated selling prices, costs, demand, competitive position and profitability of various products/services that are provided by the organization. Shareholders require information on the value of their investment and the income that is derived from their shareholding. Employees require information on the ability of the firm to meet wage demands and avoid redundancies. Creditors and the providers of loan capital require information on a firm's ability to meet its financial obligations. Government agencies like the Central Statistical Office collect accounting information and require such information as the details of sales activity, profits, investments, stocks, dividends paid, the proportion of profits absorbed by taxation and so on. In addition the Inland Revenue needs information on the amount of profits that are subject to taxation. All this information is important for determining policies to manage the economy.

Accounting information is not confined to business organizations. Accounting information about individuals is also important and is used by other individuals; for example, credit may only be extended to an individual after the prospective borrower has furnished a reasonable accounting of his private financial affairs. Non-profit-making organizations such as churches, charitable organizations, clubs and government units such as local authorities, also require accounting information for decision-making, and for reporting the results of their activities. For example, a tennis club will require information on the cost of undertaking its various activities so that a decision can be made as to the amount of the annual subscription that it will charge to its members. Similarly, local authorities need information on the costs of undertaking specific activities so that decisions can be made as to which activities will be undertaken and the resources that must be raised to finance them.

The foregoing discussion has indicated that there are many users of accounting information who require information for decision-making. The objective of accounting is to provide sufficient information to meet the needs of the various users

at the lowest possible cost. Obviously, the benefit derived from using an information system for decision-making must be greater than the cost of operating the system.

An examination of the various users of accounting information indicates that they can be divided into two categories:

1. internal parties within the organization;
2. external parties such as shareholders, creditors and regulatory agencies, outside the organization.

It is possible to distinguish between two branches of accounting, that reflect the internal and external users of accounting information. **Management accounting** is concerned with the provision of information to people within the organization to help them make better decisions and improve the efficiency and effectiveness of existing operations, whereas **financial accounting** is concerned with the provision of information to external parties outside the organization. Thus, management accounting could be called internal accounting and financial accounting could be called external accounting. This book concentrates on management accounting.

Differences between management accounting and financial accounting

The major differences between these two branches of accounting are:

- *Legal requirements.* There is a statutory requirement for public limited companies to produce annual financial accounts regardless of whether or not management regards this information as useful. Management accounting, by contrast, is entirely optional and information should be produced only if it is considered that the benefits from the use of the information by management exceed the cost of collecting it.
- *Focus on individual parts or segments of the business.* Financial accounting reports describe the whole of the business whereas management accounting focuses on small parts of the organization, for example the cost and profitability of products, services, customers and activities. In addition, management accounting information measures the economic performance of decentralized operating units, such as divisions and departments.
- *Generally accepted accounting principles.* Financial accounting statements must be prepared to conform with the legal requirements and the generally accepted accounting principles established by the regulatory bodies such as the Financial Accounting Standards Board (FASB) in the USA and the Accounting Standards Board (ASB) in the UK. These requirements are essential to ensure the uniformity and consistency that is needed for external financial statements. Outside users need assurance that external statements are prepared in accordance with generally accepted accounting principles so that the inter-company and historical comparisons are possible. In contrast, management accountants are not required to adhere to generally accepted accounting principles when providing managerial information for internal purposes. Instead, the focus is on the serving management's needs and providing information that is useful to managers relating to their decision-making, planning and control functions.

- *Time dimension.* Financial accounting reports what has happened in the past in an organization, whereas management accounting is concerned with *future* information as well as past information. Decisions are concerned with *future* events and management therefore requires details of expected *future* costs and revenues.
- *Report frequency.* A detailed set of financial accounts is published annually and less detailed accounts are published semi-annually. Management requires information quickly if it is to act on it. Consequently management accounting reports on various activities may be prepared at daily, weekly or monthly intervals.

The decision-making process

Because information produced by management accountants must be judged in the light of its ultimate effect on the outcome of decisions, a necessary precedent to an understanding of management accounting is an understanding of the *decision-making process*.

Figure 1.1 presents a diagram of a decision-making model. The first five stages represent the decision-making or the planning process. **Planning** involves making choices between alternatives and is primarily a decision-making activity. The final two stages represent the *control process*, which is the process of measuring and correcting actual performance to ensure that the alternatives that are chosen and the plans for implementing them are carried out. Let us now examine each of the items listed in Figure 1.1.

Identifying objectives

Before good decisions can be made there must be some guiding aim or direction that will enable the decision-makers to assess the desirability of favouring one course of action over another. Hence, the first stage in the decision-making process should be to specify the **goals** or **objectives of the organization**.

Considerable controversy exists as to what the objectives of firms are or should be. Economic theory normally assumes that firms seek to maximize profits for the owners of the firm (the ordinary shareholders in a limited company) or, more precisely, the maximization of shareholders' wealth. Various arguments have been used to support the profit maximization objective. There is the legal argument that the ordinary shareholders are the owners of the firm, which therefore should be run for their benefit by trustee managers. Another argument supporting the profit objective is that profit maximization leads to the maximization of overall economic welfare. That is, by doing the best for yourself, you are unconsciously doing the best for society. Moreover, it seems a reasonable belief that the interests of firms will be better served by a larger profit than by a smaller profit, so that maximization is at least a useful approximation.

Some writers (e.g. Simon, 1959) believe that businessmen are content to find a plan that provides satisfactory profits rather than to maximize profits. Because people have limited powers of understanding and can deal with only a limited amount of information at a time (Simon uses the term **bounded rationality** to describe these constraints), they tend to search for solutions only until the first acceptable solution is found. No further attempt is made to find an even better solution or to continue the

FIGURE 1.1 *The decision-making, planning and control process*



search until the best solution is discovered. Such behaviour, where the search is terminated on finding a satisfactory, rather than optimal solution, is known as **satisficing**.

Cyert and March (1969) have argued that the firm is a coalition of various different groups – shareholders, employees, customers, suppliers and the government – each of whom must be paid a minimum to participate in the coalition. Any excess benefits after meeting these minimum constraints are seen as being the object of bargaining between the various groups. In addition, a firm is subject to constraints of a societal nature. Maintaining a clean environment, employing disabled workers and providing social and recreation facilities are all examples of social goals that a firm may pursue.

Clearly it is too simplistic to say that the only objective of a business firm is to maximize profits. Some managers seek to establish a power base and build an empire; another goal is security; the removal of uncertainty regarding the future may override the pure profit motive. Nevertheless, the view adopted in this book is that, broadly, firms seek to maximize the value of future net cash inflows (that is, future cash receipts less cash payments) or to be more precise the present value of future net cash inflows.[1] This is equivalent to maximizing shareholder value. (The concept of present value is explained in Chapter 15.) The reasons for choosing this objective are as follows:

1. It is unlikely that any other objective is as widely applicable in measuring the ability of the organization to survive in the future.
2. It is unlikely that maximizing the present value of future cash flows can be realized in practice, but by establishing the principles necessary to achieve this objective you will learn how to increase the present value of future cash flows.
3. It enables shareholders as a group in the bargaining coalition to know how much the pursuit of other goals is costing them by indicating the amount of cash distributed among the members of the coalition.

The search for alternative courses of action

The second stage in the decision-making model is a search for a range of possible courses of action (or **strategies**) that might enable the objectives to be achieved. If the management of a company concentrates entirely on its present product range and markets, and market shares and cash flows are allowed to decline, there is a danger that the company will be unable to generate sufficient cash flows to survive in the future. To maximize future cash flows, it is essential that management identifies potential opportunities and threats in its current environment and takes specific steps immediately so that the organization will not be taken by surprise by any developments which may occur in the future. In particular, the company should consider one or more of the following courses of action:

1 developing *new* products for sale in *existing* markets;
2 developing *new* products for *new* markets;
3 developing *new* markets for *existing* products.

The search for alternative courses of action involves the acquisition of information concerning future opportunities and environments; it is the most difficult and important stage of the decision-making process. Ideally, firms should consider all alternative courses of action, but, in practice they consider only a few alternatives, with the search process being localized initially. If this type of routine search activity fails to produce satisfactory solutions, the search will become more widespread (Cyert and March, 1969).

Gather data about alternatives

When potential areas of activity are identified, management should assess the potential growth rate of the activities, the ability of the company to establish adequate market shares, and the cash flows for each alternative activity for various **states of nature**. Because decision problems exist in an uncertain environment, it is necessary to consider certain factors that are outside the decision-maker's control, which may occur for each alternative course of action. These uncontrollable factors are called states of nature. Some examples of possible states of nature are economic boom, high inflation, recession, the strength of competition and so on.

The course of action selected by a firm using the information presented above will commit its resources for a lengthy period of time, and how the overall place of the firm will be affected within its environment, that is, the products it makes, the markets it operates in and its ability to meet future changes. Such decisions dictate the firm's long-run possibilities and hence the type of decisions it can make in the future. These decisions are normally referred to as **long-run** or **strategic decisions**. Strategic decisions have a profound effect on the firm's future position, and it is therefore essential that adequate data are gathered about the firm's capabilities and the environment in which it operates. Because of their importance, strategic decisions should be the concern of top management.

Besides strategic or long-term decisions, management must also make decisions that do not commit the firm's resources for a lengthy period of time. Such decisions are known as **short-term** or **operating decisions** and are normally the concern of lower-level managers. Short-term decisions are based on the environment of today, and the physical, human and financial resources presently available to the firm. These are, to a considerable extent, determined by the quality of the firm's long-term decisions. Examples of short-term decisions include the following.

1. What selling prices should be set for the firm's products?
2. How many units should be produced of each product?
3. What media shall we use for advertising the firm's products?
4. What level of service shall we offer customers in terms of the number of days required to deliver an order and the after-sales service?

Data must also be gathered for short-term decisions; for example, data on the selling prices of competitors' products, estimated demand at alternative selling prices, and predicted costs for different activity levels must be assembled for pricing and output decisions. When the data have been gathered, management must decide which courses of action to take.

Select appropriate alternative courses of action

In practice, decision-making involves choosing between competing alternative courses of action and selecting the alternative that best satisfies the objectives of an organization. Assuming that our objective is to maximize future net cash inflows, the alternative selected should be based on a comparison of the differences between the cash flows. Consequently, an incremental analysis of the net cash benefits for each alternative should be applied. The alternatives are ranked in terms of net cash benefits, and those showing the greatest benefits are chosen subject to taking into account any qualitative factors. We shall discuss how incremental cash flows are measured for short-term and long-term decisions and the impact of qualitative factors in Chapters 9–15.

Implementation of the decisions

Once alternative courses of action have been selected, they should be implemented as part of the budgeting process. The **budget** is a financial plan for implementing the various decisions that management has made. The budgets for all of the various decisions are expressed in terms of cash inflows and outflows, and sales revenues and expenses. These budgets are merged together into a single unifying statement of the organization's expectations for future periods. This statement is known as a **master budget**. The master budget consists of a budgeted profit and loss account, cash flow statement and balance sheet. The budgeting process communicates to everyone in the organization the part that they are expected to play in implementing management's decisions. Chapter 16 focuses on the budgeting process.

Comparing actual and planned outcomes and responding to divergencies from plan

The final stages in the process outlined in Figure 1.1 of comparing actual and planned outcomes and responses to divergencies from plan represent the firm's control process. The managerial function of **control** consists of the measurement, reporting and subsequent correction of performance in an attempt to ensure that the firm's objectives and plans are achieved. In other words, the objective of the control process is to ensure that the work is done so as to fulfil the original intentions.

To monitor performance, the accountant produces **performance reports** and presents them to the appropriate managers who are responsible for implementing the

various decisions. Performance reports consisting of a comparison of actual outcomes (actual costs and revenues) and planned outcomes (budgeted costs and revenues) should be issued at regular intervals. Performance reports provide **feedback** information by comparing planned and actual outcomes. Such reports should highlight those activities that do not conform to plans, so that managers can devote their scarce time to focusing on these items. This process represents the application of **management by exception**. Effective control requires that corrective action is taken so that actual outcomes conform to planned outcomes. Alternatively, the plans may require modification if the comparisons indicate that the plans are no longer attainable.

The process of taking corrective action so that actual outcomes conform to planned outcomes, or the modification of the plans if the comparisons indicate that actual outcomes do not conform to planned outcomes, is indicated by the arrowed lines in Figure 1.1 linking stages 7 and 5 and 7 and 2. These arrowed lines represent '**feedback loops**'. They signify that the process is dynamic and stress the interdependencies between the various stages in the process. The feedback loop between stages 7 and 2 indicates that the plans should be regularly reviewed, and if they are no longer attainable then alternative courses of action must be considered for achieving the organization's objectives. The second loop stresses the corrective action taken so that actual outcomes conform to planned outcomes. Chapters 16–18 focus on the planning and control process.

Changing competitive environment

Prior to the 1980s many organizations in Western countries operated in a protected competitive environment. Barriers of communication and geographical distance, and sometimes protected markets, limited the ability of overseas companies to compete in domestic markets. There was little incentive for firms to maximize efficiency and improve management practices, or to minimize costs, as cost increases could often be passed on to customers. During the 1980s, however, manufacturing organizations began to encounter severe competition from overseas competitors that offered high-quality products at low prices. By establishing global networks for acquiring raw materials and distributing goods overseas, competitors were able to gain access to domestic markets throughout the world. To be successful companies now have to compete not only against domestic competitors but also against the best companies in the world.

Virtually all types of service organization have also faced major changes in their competitive environment. Before the 1980s many service organizations, such as those operating in the airlines, utilities and financial service industries, were either government-owned monopolies or operated in a highly regulated, protected and non-competitive environment. These organizations were not subject to any great pressure to improve the quality and efficiency of their operations or to improve profitability by eliminating services or products that were making losses. Furthermore, more efficient competitors were often prevented from entering the markets in which the regulated companies operated. Prices were set to cover operating costs and provide a predetermined return on capital. Hence cost increases could often be absorbed by increasing the prices of the services. Little attention was therefore given to developing cost systems that accurately measured the costs and profitability of individual services.

Privatization of government-controlled companies and deregulation in the 1980s completely changed the competitive environment in which service companies operated. Pricing and competitive restrictions were virtually eliminated. Deregulation,

intensive competition and an expanding product range created the need for service organizations to focus on cost management and develop management accounting information systems that enabled them to understand their cost base and determine the sources of profitability for their products, customers and markets. Many service organizations have only recently turned their attention to management accounting.

Focus on customer satisfaction and new management approaches

In order to compete in today's competitive environment companies have had to become more customer-driven and make customer satisfaction an overriding priority. Customers are demanding ever-improving levels of service in cost, quality, reliability, delivery, and the choice of innovative new products. Figure 1.2 illustrates this focus on customer satisfaction as the overriding priority. In order to provide customer satisfaction organizations must concentrate on those key success factors that directly affect it. Figure 1.2 identifies cost efficiency, quality, time and innovation as the key success factors. In addition to concentrating on these factors organizations are adopting new management approaches in their quest to achieve customer satisfaction. These new approaches are illustrated in Figure 1.2. They are continuous improvement, employee empowerment and total value-chain analysis. Let us now examine each of the items shown in Figure 1.2 in more detail.

The first item listed in Figure 1.2 refers to key success factors; which include cost efficiency, quality, time and innovation. Since customers will buy the product with the lowest price, all other things being equal, keeping costs low and being **cost efficient** provides an organization with a strong competitive advantage. Increased competition has also made decision errors due to poor cost information more probable and more costly. If the cost system results in distorted product costs being reported, then overcosted products will lead to higher bid prices and business lost to those competitors who are able to quote lower prices purely because their cost systems produce more accurate cost information. Alternatively, there is a danger that undercosted products will result in the acceptance of unprofitable business.

These developments have made many companies aware of the need to improve their cost systems so that they can produce more accurate cost information to determine the cost of their products, pinpoint loss-making activities and analyse profits by products, sales outlets, customers and markets.

In addition to demanding low cost product customers are demanding high quality products and services. Most companies are responding to this by focusing on **total quality management** (TQM). The goal of TQM is customer satisfaction. TQM is a term used to describe a situation where *all* business functions are involved in a process of continuous quality improvement that focuses on delivering products or services of consistently high quality in a timely fashion. The emphasis on TQM has created fresh demands on the management accounting function to expand its role by becoming involved in measuring and evaluating the quality of products and services and the activities that produce them.

Organizations are also seeking to increase customer satisfaction by providing a speedier response to customer requests, ensuring 100% on-time delivery and reducing the time taken to develop and bring new products to market. For these reasons management accounting systems now place more emphasis on **time-based measures**, which have become an important competitive variable. **Cycle time** is one measure that management accounting systems have begun to focus on. It is the length of time from

FIGURE 1.2 *Focus on customer satisfaction*



start to completion of a product or service. It consists of the sum of processing time, move time, wait time and inspection time. Move time is the amount of time it takes to transfer the product during the production process from one location to another. Wait time is the amount of time that the product sits around waiting for processing, moving, inspecting, reworking or the amount of time it spends in finished goods stock waiting to be sold and despatched. Inspection time is the amount of time making sure that the product is defect free or the amount of time actually spent reworking the product to remedy identified defects in quality. Only processing time adds value to the product, and the remaining activities are **non-value added activities** in the sense that they can be reduced or eliminated without altering the product's service potential to the customer. Organizations are therefore focusing on minimizing cycle time by reducing the time spent on such activities. The management accounting system has an important role to play in this process by identifying and reporting on the time devoted to value added and non-value added activities.

The final key success factor shown in Figure 1.2 relates to **innovation**. To be successful companies must develop a steady stream of innovative new products and services and have the capability to adapt to changing customer requirements. It has already been stressed earlier in this chapter that being later to the market than competitors can have a dramatic effect on product profitability. Companies have therefore begun to incorporate performance measures that focus on flexibility and innovation into their management accounting systems. Flexibility relates to the responsiveness in meeting customer requirements. Flexibility measures include the total launch time for new products, the length of development cycles and the ability to change the production mix quickly. Innovation measures include an assessment of the key characteristics of new products relative to those of competitors, feedback on customer satisfaction with the new features and characteristics of newly introduced products, and the number of new products launched and their launch time.

You can see by referring to Figure 1.2 that organizations are attempting to achieve customer satisfaction by adopting a philosophy of **continuous improvement**.

Traditionally, organizations have sought to establish standard operating procedures. Operators were expected to follow the standard procedures and management accountants developed systems and measurements that compared actual results with predetermined standards. This process created a climate whereby the predetermined standards represented a target to be achieved and maintained rather than a policy of continuous improvement. In today's competitive environment performance against static historical standards is no longer appropriate. To compete successfully companies must adopt a philosophy of continuous improvement, an ongoing process that involves a continuous search to reduce costs, eliminate waste, and improve the quality and performance of activities that increase customer value or satisfaction.

Benchmarking is a technique that is increasingly being adopted as a mechanism for achieving continuous improvement. It is a continuous process of measuring a firm's products, services or activities against the other best-performing organizations, either internal or external to the firm. The objective is to ascertain how the processes and activities can be improved. Ideally, benchmarking should involve an external focus on the latest developments, best practice and model examples that can be incorporated within various operations of business organizations. It therefore represents the ideal way of moving forward and achieving high competitive standards.

In their quest for the continuous improvement of organizational activities managers have found that they have had to rely more on the people closest to the operating processes and customers to develop new approaches to performing activities. This has led to employees being provided with relevant information to enable them to make continuous improvements to the output of processes. Allowing employees to take such actions without the authorization by superiors has come to be known as **employee empowerment**. It is argued that by empowering employees and giving them relevant information they will be able to respond faster to customers, increase process flexibility, reduce cycle time and improve morale. Management accounting is therefore moving from its traditional emphasis on providing information to managers to monitor the activities of employees to providing information to employees to empower them to focus on the continuous improvement of activities.

Increasing attention is now being given to **value-chain analysis** as a means of increasing customer satisfaction and managing costs more effectively. The value chain is illustrated in Figure 1.3. It is the linked set of value-creating activities all the way from basic raw material sources for component suppliers through to the ultimate end-use product or service delivered to the customer. Coordinating the individual parts of the value chain together to work as a team creates the conditions to improve customer satisfaction, particularly in terms of cost efficiency, quality and delivery. It is also appropriate to view the value chain from the customer's perspective, with each link being seen as the customer of the previous link. If each link in the value chain is designed to meet the needs of its customers, then end-customer satisfaction should ensue. Furthermore, by viewing each link in the value chain as a supplier–customer relationship, the opinions of the customers can be used to provide useful feedback information on assessing the quality of service provided by the supplier. Opportunities are thus identified for improving activities throughout the entire value chain. The aim is to manage the linkages in the value chain better than competitors and thus create a competitive advantage.

Finally, there are other aspects of customer satisfaction that are not specified in Figure 1.2 – namely, **social responsibility** and **corporate ethics**. Customers are no longer satisfied if companies simply comply with the legal requirements of undertaking their activities. They expect company managers to be more proactive in terms of their social responsibility. Company stakeholders are now giving high priority to social responsibility, safety and environmental issues, besides corporate ethics. In

FIGURE 1.3 *The value chain*



response to these pressures many companies are now introducing mechanisms for measuring, reporting and monitoring their environmental costs and activities. A code of ethics has also become an essential part of corporate culture. In addition, professional accounting organizations play an important role in promoting a high standard of ethical behaviour by their members. Both of the professional bodies representing management accountants in the UK (Chartered Institute of Management Accountants) and the USA (Institute of Management Accountants) have issued a code of ethical guidelines for their members and established mechanisms for monitoring and enforcing professional ethics. The guidelines are concerned with ensuring that accountants follow fundamental principles relating to integrity (not being a party to any falsification), objectivity (not being biased or prejudiced), confidentiality and professional competence and due care (maintaining the skills required to ensure a competent professional service).

The impact of information technology

During the past decade the use of information technology (IT) to support business activities has increased dramatically with the development of electronic business communication technologies known as **e-business**, **e-commerce** or **internet commerce**. These developments are having a big impact on businesses. For example, consumers are becoming more discerning when purchasing products or services because they are able to derive more information from the internet on the relative merits of the different product offerings. E-commerce has provided the potential to develop new ways of doing things that have enabled considerable cost savings to be made from streamlining business processes and generating extra revenues from the adept use of on-line sales facilities (e.g. ticketless airline bookings and internet banking). The ability to use e-commerce more proficiently than competitors provides the potential for companies to establish a competitive advantage.

One advanced IT application that has had a considerable impact on business information systems is **enterprise resource planning systems** (ERPS). The number of adopters of ERPS has increased rapidly throughout the world since they were first introduced in the mid-1990s. An ERPS comprises a set of integrated software applications modules that aim to control all information flows within a company. They cover most business functions (including accounting). Standard ERPS accounting modules incorporate many menus including bookkeeping, product profitability analysis and budgeting. All the modules are fully integrated in a common database and users can access real-time information on all aspects of the business. A major feature of ERPS systems is that



A look at a key feature of easyJet's business

As one of the pioneers in the low cost airline market, easyJet bases its business on a number of principles:

- Minimize distribution costs by using the internet to take bookings. About 90% of all easyJet tickets are sold via the Web. This makes the company one of Europe's largest internet retailers.
- Maximize efficient use of assets, by increasing turn-around time at airports.
- A 'simple-service model' means the end of free on-board catering.
- Ticketless travel, where passengers receive an e-mail confirming their booking, cuts the cost of issuing, distributing and processing tickets.
- Intensive use of IT in administration and management, aiming to run a paperless office.

Source: easyJet website (www.easyjet.com)

all data are entered only once, typically where the data originate. There are a number of ERPS packages on the market provided by companies such as SAP, Baan, Oracle and J.D. Edwards. SAP is the market leader with more than 7500 users in 90 countries (Scapens *et al*., 1998). The introduction of ERPS has the potential to have a significant impact on the work of management accountants. In particular, ERPS substantially reduce routine information gathering and the processing of information by management accountants. Instead of managers asking management accountants for information, they can access the system to derive the information they require directly by PC

International convergence of management accounting practices

This book has become an established text in many different countries throughout the world. It is therefore assumed that the content is appropriate for use in different countries. This assumption is based on the premise that management accounting practices generally do not differ across countries. Granlund and Lukka (1998) provide support for this assumption. They argue that there is a strong current tendency towards global homogenization of management accounting practices within the industrialized parts of the world.

Granlund and Lukka distinguish between management accounting practices at the macro and micro levels. The macro level relates to concepts and techniques; in other words, it relates mainly to the content of this book. In contrast, the micro level is concerned with the behavioural patterns relating to how management accounting information is actually used. Granlund and Lukka argue that, at the macro level, the forces of convergence have started to dominate those of divergence. They identify various drivers of convergence but the most important relate to the intensified global competition, developments in information technology, the increasing tendency of transnational companies to standardize their practices, the global consultancy industry and the use of globally applied textbooks and teaching.

Firms throughout the world are adopting similar integrated enterprise resource planning systems or standardized software packages that have resulted in the standardization of data collection formats and reporting patterns of accounting information. In multinational companies this process has resulted in the standardization of the global flow of information, but it has also limited the ability to generate locally relevant information. Besides the impact of integrated IT systems, it is common for the headquarters/parent company of a transnational enterprise to force foreign divisions to adopt similar accounting practices to those of the headquarters/parent company. A large global consultancy industry has recently emerged that tends to promote the same standard solutions globally. Finally, the same textbooks are used globally and university and professional accounting syllabuses tend to be similar in different countries.

At the micro level Granlund and Lukka acknowledge that differences in national and corporate culture can result in management accounting practices differing across countries. For example, national cultures have been categorized as the extent to which: (1) the inequality between people is considered to be normal and acceptable; (2) the culture is assertive and competitive as opposed to being modest and caring; (3) the culture feels comfortable with uncertainty and ambiguity; and (4) the culture focuses on long-term or short-term outcomes. There is evidence to suggest that accounting information is used in different ways in different national cultures, such as being used in a rigorous/rigid manner for managerial performance evaluation in cultures exhibiting certain national traits and in a more flexible way in cultures exhibiting different national traits. At the macro level Granlund and Lukka argue that the impact of national culture is diminishing because of the increasing emerging pressures to follow national trends to secure national competitiveness.

Functions of management accounting

A cost and management accounting system should generate information to meet the following requirements. It should:

1. allocate costs between cost of goods sold and inventories for internal and external profit reporting;
2. provide relevant information to help managers make better decisions;
3. provide information for planning, control and performance measurement.

Financial accounting rules require that we match costs with revenues to calculate profit. Consequently any unsold finished goods stock or partly completed stock (work in progress) will *not* be included in the cost of goods sold, which is matched against sales revenue during a given period. In an organization that produces a wide range of different products it will be necessary, for stock (inventory) valuation purposes, to charge the costs to each individual product. The total value of the stocks of completed products and work in progress plus any unused raw materials forms the basis for determining the inventory valuation to be deducted from the current period's costs when calculating profit. This total is also the basis for determining the stock valuation for inclusion in the balance sheet. Costs are therefore traced to each individual job or product for financial accounting requirements in order to allocate the costs incurred during a period between cost of goods sold and inventories. This information is required for meeting *external* financial accounting requirements, but most organizations also produce *internal* profit reports at monthly intervals. Thus product costs are

also required for periodic internal profit reporting. Many service organizations, however, do not carry any stocks and product costs are therefore not required by these organizations for valuing inventories.

The second requirement of a cost and management accounting system is to provide relevant financial information to managers to help them make better decisions. This involves both routine and non-routine reporting. Routine information is required relating to the profitability of various segments of the business such as products, services, customers and distribution channels in order to ensure that only profitable activities are undertaken. Information is also required for making resource allocation and product mix and discontinuation decisions. In some situations cost information extracted from the costing system also plays a crucial role in determining selling prices, particularly in markets where customized products and services are provided that do not have readily available market prices. Non-routine information is required for strategic decisions. These decisions are made at infrequent intervals and include decisions relating to the development and introduction of new products and services, investment in new plant and equipment and the negotiation of long-term contracts with customers and suppliers.

Management accounting systems should also provide information for planning, control and performance measurement. Planning involves translating goals and objectives into the specific activities and resources that are required to achieve the goals and objectives. Companies develop both long-term and short-term plans and the management accounting function plays a critical role in this process. Short-term plans, in the form of the budgeting process, are prepared in more detail than the longer-term plans and are one of the mechanisms used by managers as a basis for control and performance evaluation. Control is the process of ensuring that the actual outcomes conform with the planned outcomes. The control process involves the setting of targets or standards (often derived from the budgeting process) against which actual results are measured. Performance is then measured and compared with the targets on a periodic basis. The management accountant's role is to provide managers with feedback information in the form of periodic reports, suitably analysed, to enable them to determine if operations are proceeding according to plan and identify those activities where corrective action is necessary. In particular, the management accounting function should provide economic feedback to managers to assist them in controlling costs and improving the efficiency and effectiveness of operations.

It is appropriate at this point to distinguish between cost accounting and management accounting. **Cost accounting** is concerned with cost accumulation for inventory valuation to meet the requirements of external reporting and internal profit measurement, whereas **management accounting** relates to the provision of appropriate information for decision-making, planning, control and performance evaluation. It is apparent from an examination of the literature that the distinction between cost accounting and management accounting is extremely vague with some writers referring to the decision-making aspects in terms of cost accounting and other writers using the term management accounting; the two terms are often used synonymously. In this book no attempt will be made to distinguish between these two terms.

You should now be aware from the above discussion that a management accounting system serves multiple purposes. The emphasis throughout the book is that costs must be assembled in different ways for different purposes. Most firms establish one set of accounts that serve inventory valuation and profit measurement, decision-making and performance evaluation requirements. In other words, a single database is maintained with costs appropriately coded and classified so that relevant cost information can be extracted to meet each of the above requirements. We shall examine in the next chapter how relevant cost information can be extracted from a single database and adjusted to meet different user requirements.

Summary of the contents of this book

This book is divided into four parts. The first part (Part One) consists of two chapters and provides an introduction to management and cost accounting and a framework for studying the remaining chapters. Part Two consists of six chapters and is entitled 'Cost Accumulation for Inventory Valuation and Profit Measurement'. This section focuses mainly on cost accounting. It is concerned with assigning costs to products to separate costs incurred during a period between costs of goods sold and the closing inventory valuation. The extent to which product costs accumulated for inventory valuation and profit measurement should be adjusted for meeting decision-making, cost control and performance measurement requirements is also briefly considered. Part Three consists of seven chapters and is entitled 'Information for Decision-making'. Here the focus is on measuring and identifying those costs which are relevant for different types of decisions.

The title of Part Four is 'Information for Planning, Control and Performance Measurement'. It consists of three chapters and concentrates on the process of translating goals and objectives into specific activities and the resources that are required, via the short-term (budgeting) and long-term planning processes, to achieve the goals and objectives. In addition, the management control systems that organizations use are described and the role that management accounting control systems play within the overall control process is examined. The emphasis here is on the accounting process as a means of providing information to help managers control the activities for which they are responsible.

Guidelines for using this book



A comprehensive treatment of all of the topics that are contained in this book will not be essential for all readers. To meet the different requirements of the readers, the more advanced material that is not essential for those readers not requiring a more in-depth knowledge of a particular topic has been highlighted. The start of each advanced reading section has a clearly identifiable heading and a vertical orange line is used to highlight the full section. If you do require an in-depth knowledge of a topic you may find it helpful initially to omit the advanced reading sections, or skim them, on your first reading. You should read them in detail only when you fully understand the content of the remaining parts of the chapter. It is important that you check your course content to ascertain if you need to read the advanced reading section.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Distinguish between management accounting and financial accounting.**

  Management accounting differs from financial accounting in several ways. Management accounting is concerned with the provision of information to internal

users to help them make better decisions and improve the efficiency and effectiveness of operations. Financial accounting is concerned with the provision of information to external parties outside the organization. Unlike financial accounting there is no statutory requirement for management accounting to produce financial statements or follow externally imposed rules. Furthermore, management accounting provides information relating to different parts of the business whereas financial accounting reports focus on the whole business. Management accounting also tends to be more future oriented and reports are often published on a daily basis whereas financial accounting reports are published semi-annually.

- **Identify and describe the elements involved in the decision-making, planning and control process.**

  The following elements are involved in the decision-making, planning and control process: (a) identify the objectives that will guide the business; (b) search for a range of possible courses of action that might enable the objectives to be achieved; (c) gather data about the alternatives; (d) select appropriate alternative courses of action that will enable the objectives to be achieved; (e) implement the decisions as part of the planning and budgeting process; (f) compare actual and planned outcomes; and (g) respond to divergencies from plan by taking corrective action so that actual outcomes conform to planned outcomes or modify the plans if the comparisons indicate that the plans are no longer attainable.

- **Justify the view that a major objective of commercial organizations is to broadly seek to maximize the present value of future cash flows.**

  The reasons for identifying maximizing the present value of future cash flows as a major objective are: (a) it is equivalent to maximizing shareholder value; (b) it is unlikely that any other objective is as widely applicable in measuring the ability of the organization to survive in the future; (c) although it is unlikely that maximizing the present value of future cash flows can be realized in practice it is still important to establish the principles necessary to achieve this objective; and (d) it enables shareholders as a group in the bargaining coalition to know how much the pursuit of other goals is costing them by indicating the amount of cash distributed among the members of the coalition.

- **Explain the factors that have influenced the changes in the competitive environment.**

  The factors influencing the change in the competitive environment are (a) globalization of world trade; (b) privatization of government-controlled companies and deregulation in various industries; (c) changing product life cycles; (d) changing customer tastes that demand ever-improving levels of service in cost, quality, reliability, delivery and the choice of new products; and (e) the emergence of e-business.

- **Outline and describe the key success factors that directly affect customer satisfaction.**

  The key success factors are cost efficiency, quality, time and innovation. Since customers will generally prefer to buy the product or service at the lowest price, all other things being equal, keeping costs low and being cost efficient provides an organization with a strong competitive advantage. Customers also demand high quality products and services and this has resulted in companies making quality a key competitive variable. Organizations are also seeking to increase customer satisfaction by providing a speedier response to customer requests, ensuring 100 per cent on-time delivery and reducing the time taken to bring new products to the

market. To be successful companies must be innovative and develop a steady stream of new products and services and have the capability to rapidly adapt to changing customer requirements.

- **Identify and describe the functions of a management accounting system.**
  A cost and management accounting system should generate information to meet the following requirements: (a) allocate costs between cost of goods sold and inventories for internal and external profit reporting and inventory valuation; (b) provide relevant information to help managers make better decisions; and (c) provide information for planning, control and performance measurement.



Notes

1 The total profits over the life of a business are identical with total net cash inflows. However, the profits calculated for a particular accounting period will be different from the net cash flows for that period. The difference arises because of the accruals concept in financial accounting. For most situations in this book, decisions that will lead to changes in profits are also assumed to lead to identical changes in net cash flows.



Key terms and concepts

Each chapter includes a section like this. You should make sure that you understand each of the terms listed below before you proceed to the next chapter. Their meanings are explained on the page numbers indicated.

benchmarking (p. 15)
bounded rationality (p. 8)
budget (p. 11)
continuous improvement (p. 14)
control (p. 11)
corporate ethics (p. 15)
cost accounting (p. 19)
cost efficient (p. 13)
cycle time (p. 13)
e-business (p. 16)
e-commerce (p. 16)
employee empowerment (p. 15)
enterprise resource planning systems (p. 16)
feedback (p. 12)
feedback loop (p. 12)
financial accounting (pp. 7, 8)
goals of the organization (p. 8)
innovation (p. 14)
internet commerce (p. 16)
long-run decisions (p. 10)
management accounting (pp. 7, 19)
management by exception (p. 12)
master budget (p. 11)
non-value added activities (p. 14)
objectives of the organization (p. 8)
operating decisions (p. 10)
performance reports (p. 11)
planning (p. 8)
satisficing (p. 9)
short-term decisions (p. 10)
social responsibility (p. 15)
states of nature (p. 10)
strategic decisions (p. 10)
strategies (p. 10)
time-based measures (p. 13)
total quality management (p. 13)
value-chain analysis (p. 15)

Key examination points

Chapter 1 has provided an introduction to the scope of management accounting. It is unlikely that examination questions will be set that refer to the content of an introductory chapter. However, questions are sometimes set requiring you to outline how a costing system can assist the management of an organization. Note that the examiner may not distinguish between cost accounting and management accounting. Cost accounting is often used to also embrace management accounting. Your discussion of a cost accounting system should therefore include a description (with illustrations) of how the system provides information for decision-making, planning and control. Make sure that you draw off your experience from the whole of a first-year course and not just this introductory chapter.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The remaining chapters also contain review problems. These are more complex and require you to relate and apply the chapter content to various business problems. Fully worked solutions to the review problems are provided in a separate section at the end of the book.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. The Electronic Boards case is a case study that is relevant to the introductory stages of a management accounting course.

Review questions

1.1 Identify and describe the different users of accounting information. *(pp. 6–7)*

1.2 Describe the differences between management accounting and financial accounting. *(pp. 7–8)*

1.3 Explain each of the elements of the decision-making, planning and control process. *(pp. 8–12)*

1.4 Describe what is meant by management by exception. *(p. 12)*

1.5 Describe what is meant by continuous improvement, benchmarking and employee empowerment. *(pp. 14–15)*

1.6 Describe the different activities in the value chain. *(p. 15)*

1.7 Explain why firms are beginning to concentrate on social responsibility and corporate ethics. *(pp. 15–16)*

1.8 Describe the different functions of management accounting. *(pp. 18–19)*

1.9 Describe enterprise resource planning systems and their impact on management accountants. *(pp. 16–17)*



An introduction to cost terms and concepts

2

In Chapter 1 it was pointed out that accounting systems measure costs which are used for profit measurement and inventory valuation, decision-making, performance measurement and controlling the behaviour of people. The term cost is a frequently used word that reflects a monetary measure of the resources sacrificed or forgone to achieve a specific objective, such as acquiring a good or service. However, the term must be defined more precisely before the 'cost' can be determined. You will find that the word *cost* is rarely used without a preceding adjective to specify the type of cost being considered.

To understand how accounting systems calculate costs and to communicate accounting information effectively to others requires a thorough understanding of what cost means. Unfortunately, the term has multiple meanings and different types of costs are used in different situations. Therefore a preceding term must be added to clarify the assumptions that underlie a cost measurement. A large terminology has emerged to indicate more clearly which cost meaning is being conveyed. Examples include variable cost, fixed cost, opportunity cost and sunk cost. The aim of this chapter is to provide you with an understanding of the basic cost terms and concepts that are used in the management accounting literature.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- explain why it is necessary to understand the meaning of different cost terms;
- define and illustrate a cost object;
- explain the meaning of each of the key terms listed at the end of this chapter;
- explain why in the short term some costs and revenues are not relevant for decision-making;
- distinguish between job costing and process costing;
- describe the three purposes for which cost information is required.

Cost objects

A **cost object** is any activity for which a separate measurement of costs is desired. In other words, if the users of accounting information want to know the cost of something, this something is called a cost object. Examples of cost objects include the cost of a product, the cost of rendering a service to a bank customer or hospital patient, the cost of operating a particular department or sales territory, or indeed anything for which one wants to measure the cost of resources used.

We shall see that the cost collection system typically accounts for costs in two broad stages:

1. It accumulates costs by classifying them into certain categories such as labour, materials and overhead costs (or by cost behaviour such as fixed and variable).
2. It then assigns these costs to cost objects.

In this chapter we shall focus on the following cost terms and concepts:

- direct and indirect costs;
- period and product costs;
- cost behaviour in relation to volume of activity;
- relevant and irrelevant costs;
- avoidable and unavoidable costs;
- sunk costs;
- opportunity costs;
- incremental and marginal costs.

Direct and indirect costs

Costs that are assigned to cost objects can be divided into two categories: direct costs and indirect costs. **Direct costs** are those costs that can be specifically and exclusively identified with a particular cost object. In contrast, **indirect costs** cannot be identified specifically and exclusively with a given cost object. Let us assume that our cost object is a product, or to be more specific a particular type of desk that is manufactured by an organization. In this situation the wood that is used to manufacture the desk can be specifically and exclusively identified with a particular desk and can thus be classified as a direct cost. Similarly, the wages of operatives whose time can be traced to the specific desk are a direct cost. In contrast, the salaries of factory supervisors or the rent of the factory cannot be specifically and exclusively traced to a particular desk and these costs are therefore classified as indirect.

Sometimes, however, direct costs are treated as indirect because tracing costs directly to the cost object is not cost-effective. For example, the nails used to manufacture a particular desk can be identified specifically with the desk, but, because the cost is likely to be insignificant, the expense of tracing such items does not justify the possible benefits from calculating more accurate product costs.

Direct costs can be accurately traced because they can be physically identified with a particular object whereas indirect costs cannot. An estimate must be made of resources consumed by cost objects for indirect costs. Therefore, the more direct costs that can be traced to a cost object, the more accurate is the cost assignment.

The distinction between direct and indirect costs also depends on the cost object. A cost can be treated as direct for one cost object but indirect in respect of another. If the cost object is the cost of using different distribution channels, then the rental of warehouses and the salaries of storekeepers will be regarded as direct for each distribution channel. Also consider a supervisor's salary in a maintenance department of a manufacturing company. If the cost object is the maintenance department, then the salary is a direct cost. However, if the cost object is the product, both the warehouse rental and the salaries of the storekeepers and the supervisor will be an indirect cost because these costs cannot be specifically identified with the product.

Categories of manufacturing costs

In manufacturing organizations products are frequently the cost object. Traditionally, cost accounting systems in manufacturing organizations have reflected the need to assign costs to products to value stocks and measure profits based on imposed external financial accounting requirements. Cost accounting systems typically accumulate product costs as follows:

Direct materials	xxx
Direct labour	xxx
Prime cost	xxx
Manufacturing overhead	xxx
Total manufacturing cost	xxx

Direct materials consist of all those materials that can be identified with a specific product. For example, wood that is used to manufacture a desk can easily be identified as part of the product, and can thus be classified as direct materials. Alternatively, materials used for the repair of a machine that is used for the manufacture of many different desks are classified as **indirect materials**. These items of materials cannot be identified with any one product, because they are used for the benefit of all products rather than for any one specific product. Note that indirect materials form part of the manufacturing overhead cost.

Direct labour consists of those labour costs that can be specifically traced to or identified with a particular product. Examples of direct labour costs include the wages of operatives who assemble parts into the finished product, or machine operatives engaged in the production process. By contrast, the salaries of factory supervisors or the wages paid to the staff in the stores department cannot be specifically identified with the product, and thus form part of the **indirect labour costs**. The wages of all employees who do not work on the product itself but who assist in the manufacturing operation are thus classified as part of the indirect labour costs. As with indirect materials, indirect labour is classified as part of the manufacturing overhead cost.

Prime cost refers to the direct costs of the product and consists of direct labour costs plus direct material costs plus any direct expenses. The cost of hiring a machine for producing a specific product is an example of a direct expense.

Manufacturing overhead consists of all manufacturing costs other than direct labour, direct materials and direct expenses. It therefore includes all indirect manufacturing labour and materials costs plus indirect manufacturing expenses. Examples of indirect manufacturing expenses in a multi-product company include rent of the factory and depreciation of machinery.

To ascertain the total manufacturing cost of a product, all that is required for the direct cost items is to record the amount of resources used on the appropriate documents. The

specific product or order (i.e. the cost object) to which the costs should be assigned should be entered on the document. For example, the units of materials used in making a particular product are recorded on a stores requisition, and the hours of direct labour used are recorded on job cards. Having obtained the quantity of resources used for the direct items, it is necessary to ascertain the price paid for these resources. The total of the resources used multiplied by the price paid per unit of resources used provides us with the total of the direct costs or the prime cost for a product.

Manufacturing overheads cannot be directly traced to products. Instead they are assigned to products using **cost allocations**. A cost allocation is the process of estimating the cost of resources consumed by products that involves the use of surrogate, rather than direct measures. The process of assigning indirect costs (overheads) to cost objects will be explained in Chapter 4.

Period and product costs

External financial accounting rules in most countries require that for inventory valuation, only manufacturing costs should be included in the calculation of product costs (see United Kingdom Statement of Standard Accounting Practice [SSAP 9] and International Accounting Standard 2), published by the Accounting Standards Committee). Accountants therefore classify costs as product costs and period costs. **Product costs** are those costs that are identified with goods purchased or produced for resale. In a manufacturing organization they are costs that the accountant attaches to the product and that are included in the inventory valuation for finished goods, or for partly completed goods (work in progress), until they are sold; they are then recorded as expenses and matched against sales for calculating profit. **Period costs** are those costs that are not included in the inventory valuation and as a result are treated as expenses in the period in which they are incurred. *Hence no attempt is made to attach period costs to products for inventory valuation purposes.*

In a manufacturing organization all manufacturing costs are regarded as product costs and non-manufacturing costs are regarded as period costs. Companies operating in the merchandising sector, such as retailing or wholesaling organizations, purchase goods for resale without changing their basic form. The cost of the goods purchased is regarded as a product cost and all other costs such as administration and selling and distribution expenses are considered to be period costs. The treatment of period and product costs for a manufacturing organization is illustrated in Figure 2.1. You will see that both product and period costs are eventually classified as expenses. The major difference is the point in time at which they are so classified.

Why are non-manufacturing costs treated as period costs and not included in the inventory valuation? There are two reasons. First, inventories are assets (unsold production) and assets represent resources that have been acquired that are expected to contribute to future revenue. Manufacturing costs incurred in making a product can be expected to generate future revenues to cover the cost of production. There is no guarantee, however, that non-manufacturing costs will generate future revenue, because they do not represent value added to any specific product. Therefore, they are not included in the inventory valuation. Second, many non-manufacturing costs (e.g. distribution costs) are not incurred when the product is being stored. Hence it is inappropriate to include such costs within the inventory valuation.

An illustration of the accounting treatment of period and product costs for income (profit) measurement purposes is presented in Example 2.1.

EXAMPLE 2.1

The Laurs company produces 100 000 identical units of a product during period 1. The costs for the period are as follows:

	(£)	(£)
Manufacturing costs:		
Direct labour	400 000	
Direct materials	200 000	
Manufacturing overheads	200 000	800 000
Non-manufacturing costs		300 000

During period 1, the company sold 50 000 units for £750 000, and the remaining 50 000 units were unsold at the end of the period. There was no opening stock at the start of the period. The profit and loss account for period 1 will be as follows:

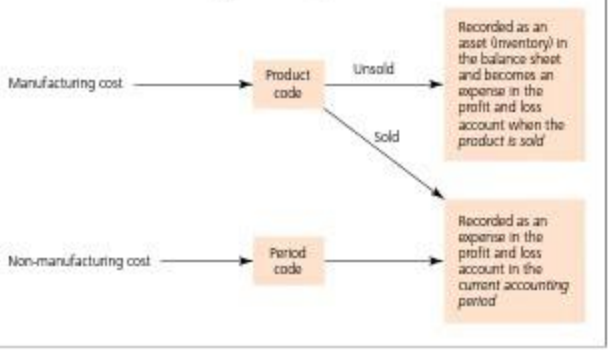
	(£)	(£)
Sales (50 000)		750 000
Manufacturing costs (*product costs*):		
Direct labour	400 000	
Direct materials	200 000	
Manufacturing overheads	200 000	
	800 000	
Less closing stock (50% or 50 000 units)	400 000	
Cost of goods sold (50% or 50 000 units)		400 000
Gross profit		350 000
Less non-manufacturing costs (*period costs*)		300 000
Net profit		50 000

Fifty per cent of the production was sold during the period and the remaining 50% was produced for inventories. Half of the product costs are therefore identified as an expense for the period and the remainder are included in the closing inventory valuation. If we assume that the closing inventory is sold in the next accounting period, the remaining 50% of the product costs will become expenses in the next accounting period. However, all the period costs became an expense in this accounting period, because this is the period to which they relate. Note that only product costs form the basis for the calculation of cost of goods sold, and that period costs do not form part of this calculation.

Cost behaviour

A knowledge of how costs and revenues will vary with different levels of activity (or volume) is essential for decision-making. Activity or volume may be measured in terms of units of production or sales, hours worked, miles travelled, patients seen, students enrolled or any other appropriate measure of the activity of an organization.

FIGURE 2.1 *Treatment of period and product costs*



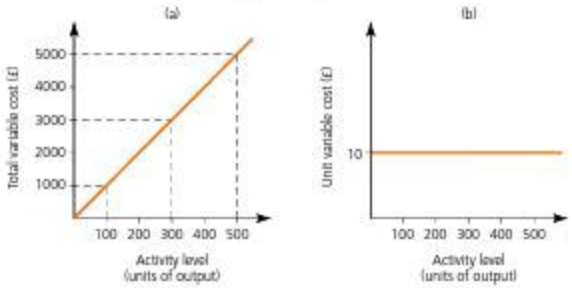
Examples of decisions that require information on how costs and revenues vary with different levels of activity include the following:

1. What should the planned level of activity be for the next year?
2. Should we reduce the selling price to sell more units?
3. Would it be wiser to pay our sales staff by a straight commission, a straight salary, or by some combination of the two?
4. How do the costs and revenues of a hospital change if one more patient is admitted for a seven-day stay?
5. How do the costs and revenues of a hotel change if a room and meals are provided for two guests for a seven-day stay?
6. How will costs and revenues change if output is increased (or decreased) by 15%?

For each of the above decisions management requires estimates of costs and revenues at different levels of activity for the alternative courses of action.

The terms 'variable', 'fixed', 'semi-variable' and 'semi-fixed' have been traditionally used in the management accounting literature to describe how a cost reacts to changes in activity. Short-term **variable costs** vary in direct proportion to the volume of activity; that is, doubling the level of activity will double the total variable cost. Consequently, *total* variable costs are linear and *unit* variable cost is constant. Figure 2.2 illustrates a variable cost where the variable cost per unit of activity is £10. It is unlikely that variable cost per unit will be constant for all levels of activity. We shall discuss the reasons why accountants normally assume that variable costs are constant per unit of activity in Chapter 9. Examples of short-term variable manufacturing costs include piecework labour, direct materials and energy to operate the machines. These costs are assumed to fluctuate directly in proportion to operating activity within a certain range of activity. Examples of non-manufacturing variable costs include sales commissions, which fluctuate with sales value, and petrol, which fluctuates with the number of miles travelled.

FIGURE 2.2 *Variable costs: (a) total; (b) unit*



Fixed costs remain constant over wide ranges of activity for a specified time period. Examples of fixed costs include depreciation of the factory building, supervisors' salaries and leasing charges for cars used by the salesforce. Figure 2.3 illustrates fixed costs.

You will see that the *total* fixed costs are constant for all levels of activity whereas *unit* fixed costs decrease proportionally with the level of activity. For example, if the total of the fixed costs is £5000 for a month the fixed costs per unit will be as follows:

Units produced	Fixed cost per unit (£)
1	5000
10	500
100	50
1000	5

Because unit fixed costs are not constant per unit they must be interpreted with caution. For decision-making, it is better to work with total fixed costs rather than unit costs.

In practice it is unlikely that fixed costs will be constant over the full range of activity. They may increase in steps in the manner depicted in Figure 2.4. We shall discuss the justification for assuming that fixed costs are constant over a wide range of activity in Chapter 9.

The distinction between fixed and variable costs must be made relative to the time period under consideration. Over a sufficiently long time period of several years, virtually all costs are variable. During such a long period of time, contraction in demand will be accompanied by reductions in virtually all categories of costs. For example, senior managers can be released, machinery need not be replaced and even buildings and land can be sold. Similarly, large expansions in activity will eventually cause all categories of costs to increase.

Within shorter time periods, costs will be fixed or variable in relation to changes in activity. The shorter the time period, the greater the probability that a particular cost will be fixed. Consider a time period of one year. The costs of providing the firm's

FIGURE 2.3 *Fixed costs: (a) total; (b) unit*

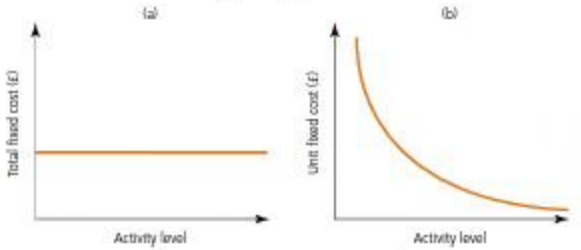


FIGURE 2.4 *Step fixed costs*



operating capacity such as depreciation and the salaries of senior plant managers are likely to be fixed in relation to changes in activity. Decisions on the firm's intended future potential level of operating capacity will determine the amount of capacity costs to be incurred. These decisions will have been made previously as part of the long-term planning process. Once these decisions have been made, they cannot easily be reversed in the short term. Plant investment and abandonment decisions should not be based on short-term fluctuations in demand within a particular year. Instead, they should be reviewed periodically as part of the long-term planning process and decisions made based on long-run demand over several years. Thus capacity costs will tend to be fixed in relation to changes of activity within short-term periods such as one year. However, over long-term periods of several years, significant changes in demand will cause capacity costs to change.

Spending on some fixed costs, such as direct labour and supervisory salaries, can be adjusted in the short term to reflect changes in activity. For example, if production activity declines significantly then direct workers and supervisors might continue to be employed in the hope that the decline in demand will be temporary; but if there is no upsurge in demand then staff might eventually be made redundant. If, on the other hand, production capacity expands to some critical level, additional workers might be

employed, but the process of recruiting such workers may take several months. Thus within a short-term period, such as one year, labour costs can change in response to changes in demand in a manner similar to that depicted in Figure 2.4. Costs that behave in this manner are described as **semi-fixed** or **step fixed costs**. The distinguishing feature of step fixed costs is that within a given time period they are fixed within specified activity levels, but they eventually are subject to step increases or decreases by a constant amount at various critical activity levels as illustrated in Figure 2.4.

Our discussion so far has assumed a one-year time period. Consider a shorter time period such as one month and the circumstances outlined in the previous paragraph where it takes several months to respond to changes in activity and alter spending levels. Over very short-term periods such as one month, spending on direct labour and supervisory salaries will be fixed in relation to changes in activity.

You should now understand that over a given short-term period, such as one year, costs will be variable, fixed or semi-fixed. Over longer-term time periods of several years, all costs will tend to change in response to large changes in activity (or to changes in the range and variety of products or services marketed), and fixed costs will become semi-fixed and change in the manner depicted in Figure 2.4. Because fixed costs do not remain fixed in the long-term, some writers prefer to describe them as **long-term variable costs**, but we shall continue to use the term fixed costs since this is the term most widely used in the literature.

Note, however, that in the short term, even though fixed costs are normally assumed to remain unchanged in response to changes in the level of activity, they may change in response to other factors. For example, if price levels increase then some fixed costs such as management salaries will increase.

Before concluding our discussion of cost behaviour in relation to volume of activity, we must consider **semi-variable costs** (also known as **mixed costs**). These include both a fixed and a variable component. The cost of maintenance is a semi-variable cost consisting of planned maintenance that is undertaken whatever the level of activity, and a variable element that is directly related to the level of activity. A further example of a semi-variable cost is where sales representatives are paid a fixed salary plus a commission on sales.

Relevant and irrelevant costs and revenues

For decision-making, costs and revenues can be classified according to whether they are relevant to a particular decision. **Relevant costs and revenues** are those *future* costs and revenues that will be changed by a decision, whereas **irrelevant costs and revenues** are those that will not be affected by the decision. For example, if you are faced with a choice of making a journey using your own car or by public transport, the car tax and insurance costs are irrelevant, since they will remain the same whatever alternative is chosen. However, petrol costs for the car will differ depending on which alternative is chosen, and this cost will be relevant for decision-making.

Let us now consider a further illustration of the classification of relevant and irrelevant costs. Assume a company purchased raw materials a few years ago for £100 and that there appears to be no possibility of selling these materials or using them in future production apart from in connection with an enquiry from a former customer. This customer is prepared to purchase a product that will require the use of all these materials, but he is not prepared to pay more than £250 per unit. The additional costs of converting these materials into the required product are £200. Should the company accept the order for £250? It appears that the cost of the order is £300, consisting of



The impact of cost structure on airline costs

Once a flight is scheduled, airlines are faced with a cost structure where the variable cost of filling a seat is minimal but the fixed costs per aircraft relating to the number of passengers taking a particular flight are extremely high. The costs of taking a meal represent the main variable costs. The costs of the cabin flight crew are a step-fixed cost and the fixed costs include aircraft depreciation, gate rentals, fuel and maintenance. Adding one more passenger to an aircraft therefore results in additional revenue but has little impact on total cost. How much? One industry study indicated that yanking just four of the 141 seats from one MD-80 jet would mean an $87,603 annual revenue loss for an airline but an almost inconsequential savings in total costs. Removing only two of 127 seats in a different aircraft would sacrifice annual revenue of $51,903. Therefore every seat counts and this has resulted in the major airlines stuffing more and more seats into aircraft. Giant 747s, once configured with nine seats across, now frequently have 10. USAir Group Inc. has packed 163 seats into 727-200 narrow-body jets that 10 years ago seated only 145. United Airlines added five rows of seats to its big DC-10-30 planes in the past decade, raising the number of seats to nearly 300 from 232.

Source: McCarty, Michael J (1994), 'Airline Squeeze play: more seats, less legroom,' *The Wall Street Journal*, 18 April, pp. B1 and B6.

£100 material cost and £200 conversion cost, but this is incorrect because the £100 material cost will remain the same whether the order is accepted or rejected. The material cost is therefore irrelevant for the decision, but if the order is accepted the conversion costs will change by £200, and this conversion cost is a relevant cost. If we compare the revenue of £250 with the relevant cost for the order of £200, it means that the order should be accepted, assuming of course that no higher-priced orders can be obtained elsewhere. The following calculation shows that this is the correct decision.

	Do not accept order (£)	Accept order (£)
Materials	100	100
Conversion costs	—	200
Revenue	—	(250)
Net costs	100	50

The net costs of the company are £50 less, or alternatively the company is £50 better off as a result of accepting the order. This agrees with the £50 advantage which was suggested by the relevant cost method.

In this illustration the sales revenue was relevant to the decision because future revenue changed depending on which alternative was selected; but sales revenue may also be irrelevant for decision-making. Consider a situation where a company can meet its sales demand by purchasing either machine A or machine B. The output of both machines is identical, but the operating costs and purchase costs of the machines

are different. In this situation the sales revenue will remain unchanged irrespective of which machine is purchased (assuming of course that the quality of output is identical for both machines). Consequently, sales revenue is irrelevant for this decision; the relevant items are the operating costs and the cost of the machines. We have now established an important principle regarding the classification of cost and revenues for decision-making; namely, that in the short term not all costs and revenues are relevant for decision-making.

Avoidable and unavoidable costs

Sometimes the terms **avoidable** and **unavoidable costs** are used instead of relevant and irrelevant cost. Avoidable costs are those costs that may be saved by not adopting a given alternative, whereas unavoidable costs cannot be saved. Therefore, only avoidable costs are relevant for decision-making purposes. Consider the example that we used to illustrate relevant and irrelevant costs. The material costs of £100 are unavoidable and irrelevant, but the conversion costs of £200 are avoidable and hence relevant. The decision rule is to accept those alternatives that generate revenues in excess of the avoidable costs.

Sunk costs

These costs are the cost of resources already acquired where the total will be unaffected by the choice between various alternatives. They are costs that have been created by a decision made in the past and that cannot be changed by any decision that will be made in the future. The expenditure of £100 on materials that were no longer required, referred to in the preceding section, is an example of a **sunk cost**. Similarly, the written down values of assets previously purchased are sunk costs. For example, if a machine was purchased four years ago for £100 000 with an expected life of five years and nil scrap value then the written down value will be £20 000 if straight line depreciation is used. This written down value will have to be written off, no matter what possible alternative future action might be chosen. If the machine was scrapped, the £20 000 would be written off; if the machine was used for productive purposes, the £20 000 would still have to be written off. This cost cannot be changed by any future decision and is therefore classified as a sunk cost.

Sunk costs are irrelevant for decision-making, but they are distinguished from irrelevant costs because not all irrelevant costs are sunk costs. For example, a comparison of two alternative production methods may result in identical direct material expenditure for both alternatives, so the direct material cost is irrelevant because it will remain the same whichever alternative is chosen, but the material cost is not sunk cost since it will be incurred in the future.

Opportunity costs

Some costs for decision-making cannot normally be collected within the accounting system. Costs that are collected within the accounting system are based on past payments or commitments to pay at some time in the future. Sometimes it is necessary

for decision-making to impute costs that will not require cash outlays, and these imputed costs are called opportunity costs. An **opportunity cost** is a cost that measures the opportunity that is lost or sacrificed when the choice of one course of action requires that an alternative course of action be given up. Consider the information presented in Example 2.2.

It is important to note that opportunity costs only apply to the use of scarce resources. Where resources are not scarce, no sacrifice exists from using these resources. In Example 2.2 if machine X was operating at 80% of its potential capacity then the decision to accept the contract would not have resulted in reduced production of product A. Consequently, there would have been no loss of revenue, and the opportunity cost would be zero.

You should now be aware that opportunity costs are of vital importance for decision-making. If no alternative use of resources exist then the opportunity cost is zero, but if resources have an alternative use, and are scarce, then an opportunity cost does exist.

EXAMPLE 2.2

A company has an opportunity to obtain a contract for the production of a special component. This component will require 100 hours of processing on machine X. Machine X is working at full capacity on the production of product A, and the only way in which the contract can be fulfilled is by reducing the output of product A. This will result in a lost profit contribution of £200. The contract will also result in *additional* variable costs of £1000.

If the company takes on the contract, it will sacrifice a profit contribution of £200 from the lost output of product A. This represents an opportunity cost, and should be included as part of the cost when negotiating for the contract. The contract price should at least cover the additional costs of £1000 plus the £200 opportunity cost to ensure that the company will be better off in the short term by accepting the contract.

Incremental and marginal costs

Incremental (also called **differential**) **costs** and revenues are the difference between costs and revenues for the corresponding items under each alternative being considered. For example, the incremental costs of increasing output from 1000 to 1100 units per week are the additional costs of producing an extra 100 units per week. Incremental costs may or may not include fixed costs. If fixed costs change as a result of a decision, the increase in costs represents an incremental cost. If fixed costs do not change as a result of a decision, the incremental costs will be zero.

Incremental costs and revenues are similar in principle to the economist's concept of **marginal cost** and **marginal revenue**. The main difference is that marginal cost/revenue represents the additional cost/revenue of one extra unit of output whereas incremental cost/revenue represents the additional cost/revenue resulting from a group of additional units of output. The economist normally represents the theoretical relationship between cost/revenue and output in terms of the marginal cost/revenue of single additional units of output. We shall see that the accountant is normally more interested in the incremental cost/revenue of increasing production and sales to whatever extent is contemplated, and this is most unlikely to be a single unit of output.

Job costing and process costing systems

There are two basic types of systems that companies can adopt – job costing and process costing systems. **Job costing** relates to a costing system that is required in organizations where each unit or batch of output of a product or service is unique. This creates the need for the cost of each unit to be calculated separately. The term 'job' thus relates to each unique unit or batch of output. Job costing systems are used in industries that provide customized products or services. For example, accounting firms provide customized services to clients with each client requiring services that consume different quantities of resources. Engineering companies often make machines to meet individual customer specifications. The contracts undertaken by construction and civil engineering companies differ greatly for each customer. In all of these organizations costs must be traced to each individual customer's order.

In contrast, **process costing** relates to those situations where masses of identical units are produced and it is unnecessary to assign costs to individual units of output. Products are produced in the same manner and consume the same amount of direct costs and overheads. It is therefore unnecessary to assign costs to individual units of output. Instead, the average cost per unit of output is calculated by dividing the total costs assigned to a product or service for a period by the number of units of output for that period. Industries where process costing is widely used include chemical processing, oil refining, food processing and brewing.

In practice these two costing systems represent extreme ends of a continuum. The output of many organizations requires a combination of the elements of both job costing and process costing.

Maintaining a cost database

In the previous chapter we noted that a cost and management accounting system should generate information to meet the following requirements:

1. to allocate costs between cost of goods sold and inventories for internal and external profit measurement and inventory valuation;
2. to provide relevant information to help managers make better decisions;
3. to provide information for planning, control and performance measurement.

A database should be maintained, with costs appropriately coded and classified, so that relevant cost information can be extracted to meet each of the above requirements.

A suitable coding system enables costs to be accumulated by the required cost objects (such as products or services, departments, responsibility centres, distribution channels, etc.) and also to be classified by appropriate categories. Typical cost classifications within the database are by categories of expense (direct materials, direct labour and overheads) and by cost behaviour (fixed and variable). In practice, direct materials will be accumulated by each individual type of material, direct labour by different grades of labour and overhead costs by different categories of indirect expenses (e.g. rent, depreciation, supervision, etc.).

For *inventory valuation* the costs of all partly completed products (work in progress) and unsold finished products can be extracted from the database to ascertain the total cost assigned to inventories. The cost of goods sold that is deducted from sales revenues to compute the profit for the period can also be extracted by summing the manufacturing costs of all those products that have been sold during the period.

The allocation of costs to products is inappropriate for *cost control and performance measurement*, as the manufacture of the product may consist of several different operations, all of which are the responsibility of different individuals. To overcome this problem, costs and revenues must be traced to the individuals who are responsible for incurring them. This system is known as **responsibility accounting**.

Responsibility accounting involves the creation of responsibility centres. A **responsibility centre** may be defined as an organization unit for whose performance a manager is held accountable. Responsibility accounting enables accountability for financial results and outcomes to be allocated to individuals throughout the organization. The objective of responsibility accounting is to measure the results of each responsibility centre. It involves accumulating costs and revenues for each responsibility centre so that deviations from a performance target (typically the budget) can be attributed to the individual who is accountable for the responsibility centre.

For *cost control and performance measurement* the accountant produces performance reports at regular intervals for each responsibility centre. The reports are generated by extracting from the database costs analysed by responsibility centres and categories of expenses. Actual costs for each item of expense listed on the performance report should be compared with budgeted costs so that those costs that do not conform to plan can be pinpointed and investigated.

Future costs, rather than past costs, are required for *decision-making*. Therefore costs extracted from the database should be adjusted for anticipated price changes. We have noted that classification of costs by cost behaviour is important for evaluating the financial impact of expansion or contraction decisions. Costs, however, are not classified as relevant or irrelevant within the database because relevance depends on the circumstances. Consider a situation where a company is negotiating a contract for the sale of one of its products with a customer in an overseas country which is not part of its normal market. If the company has temporary excess capacity and the contract is for 100 units for one month only, then the direct labour cost will remain the same irrespective of whether or not the contract is undertaken. The direct labour cost will therefore be irrelevant. Let us now assume that the contract is for 100 units per month for three years and the company has excess capacity. For long-term decisions direct labour will be a relevant cost because if the contract is not undertaken direct labour can be redeployed or made redundant. Undertaking the contract will result in additional direct labour costs.

The above example shows that the classification of costs as relevant or irrelevant depends on the circumstances. In one situation a cost may be relevant, but in another the same cost may not be relevant. Costs can only be classified as relevant or irrelevant when the circumstances have been identified relating to a particular decision.

Where a company sells many products or services their profitability should be monitored at regular intervals so that potentially unprofitable products can be highlighted for a more detailed study of their future viability. This information is extracted from the database with costs reported by categories of expenses and divided into their fixed and variable elements. In Chapter 10 we shall focus in more detail on product/segmented profitability analysis. Finally, you should note that when the activities of an organization consist of a series of common or repetitive operations, targets or standard product costs, rather than actual costs, may be recorded in the database. Standard costs are predetermined costs; they are target costs that should be incurred under efficient operating conditions. They should be reviewed and updated at periodic intervals. If product standard costs are recorded in the database there is no need continuously to trace costs to products and therefore a considerable amount of data processing time can be saved. Actual costs, however, will still be traced to responsibility centres for cost control and performance evaluation.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain why it is necessary to understand the meaning of different cost terms.**

  The term 'cost' has multiple meanings and different types of costs are used in different situations. Therefore, a preceding term must be added to clarify the assumptions that underlie a measurement.

- **Define and illustrate a cost object.**

  A cost object is any activity for which a separate measurement of cost is required. In other words managers often want to know the cost of something and the 'thing' that they want to know the cost of is a cost object. Examples of cost objects include the cost of a new product, the cost of operating a sales outlet and the cost of operating a specific machine.

- **Explain the meaning of each of the key terms listed at the end of this chapter.**

  You should check your understanding of each of the terms listed in the key terms and concepts section below by referring to the page numbers that are shown in the parentheses following each key term.

- **Explain why in the short term some costs and revenues are not relevant for decision-making.**

  In the short term some costs and revenues may remain unchanged for all alternatives under consideration. For example, if you wish to determine the costs of driving to work in your own car or using public transport, the cost of the road fund taxation licence and insurance will remain the same for both alternatives, assuming that you intend to keep your car for leisure purposes. Therefore the costs of these items are not relevant for assisting you in your decision to travel to work by public transport or using your own car. Costs that remain unchanged for all alternatives under consideration are not relevant for decision-making.

- **Distinguish between job costing and process costing.**

  A job costing system relates to a costing system where each unit or batch of output of product(s) or service(s) is unique. This creates the need for the cost of each unit or batch to be calculated separately. In contrast a process costing system relates to situations where masses of identical units or batches are produced thus making it unnecessary to assign costs to individual units or batches of output. Instead, the average cost per unit or batch of output is calculated by dividing the total costs assigned to a product or service for the period by the number of units or batches of output for that period.

- **Describe the three purposes for which cost information is required.**

  A cost and management accounting system should generate information to meet the following requirements:

  (a) to allocate costs between cost of goods sold and inventories for internal and external profit reporting and inventory valuation;
  (b) to provide relevant information to help managers make better decisions;
  (c) to provide information for planning, control and performance measurement.

  A database should be maintained with costs appropriately coded or classified, so that relevant information can be extracted for meeting each of the above requirements.



Key terms and concepts

avoidable costs (p. 37)
cost allocations (p. 30)
cost object (p. 28)
differential costs (p. 38)
direct costs (p. 28)
direct labour (p. 29)
direct materials (p. 29)
fixed costs (p. 33)
incremental costs (p. 38)
indirect costs (p. 28)
indirect labour costs (p. 29)
indirect materials (p. 29)
irrelevant costs and revenues (p. 35)
job costing (p. 39)
long-term variable costs (p. 35)
manufacturing overhead (p. 29)
marginal cost/revenue (p. 38)
mixed costs (p. 35)
opportunity cost (p. 38)
period costs (p. 30)
prime cost (p. 29)
process costing (p. 39)
product costs (p. 30)
relevant costs and revenues (p. 35)
responsibility accounting (p. 40)
responsibility centre (p. 40)
semi-fixed costs (p. 35)
semi-variable costs (p. 35)
step fixed costs (p. 35)
sunk cost (p. 37)
unavoidable costs (p. 37)
variable costs (p. 32)

Key examination points

First year management accounting course examinations frequently involve short essay questions requiring you to describe various cost terms or to discuss the concept that different costs are required for different purposes (see Review problems 2.24–2.31 for examples). It is therefore important that you understand all of the cost terms that have been described in this chapter. In particular, you should be able to explain the context within which a cost term is normally used. For example, a cost such as wages paid to casual labourers will be classified as indirect for inventory valuation purposes but as a direct charge to a responsibility centre or department for cost control purposes. A common error is for students to produce a very short answer, but you must be prepared to expand your answer and to include various situations within which the use of a cost term is appropriate. Always make sure your answer includes illustrations of cost terms. Multiple choice questions are also often set on topics included in this chapter. Review problems 2.17–2.23 are typical examples of such questions. You should now attempt these and compare your answers with the solutions.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in the parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 584-5. The Electronic Boards case is a case study that is relevant to the introductory stages of a management accounting course.

Review questions

2.1 Define the meaning of the term 'cost object' and provide three examples of cost objects. *(p. 28)*

2.2 Distinguish between a direct and indirect cost. *(p. 28)*

2.3 Describe how a given direct cost item can be both a direct and indirect cost. *(p. 29)*

2.4 Provide examples of each of the following: (a) direct labour, (b) indirect labour, (c) direct materials, (d) indirect materials, and (e) indirect expenses. *(p. 29)*

2.5 Explain the meaning of the terms: (a) prime cost, (b) overheads, and (c) cost allocations. *(pp. 29–30)*

2.6 Distinguish between product costs and period costs. *(p. 30)*

2.7 Provide examples of decisions that require knowledge of how costs and revenues vary with different levels of activity. *(p. 32)*

2.8 Explain the meaning of each of the following terms: (a) variable costs, (b) fixed costs, (c) semi-fixed costs, and (d) semi-variable costs. Provide examples of costs for each of the four categories. *(pp. 32–35)*

2.9 Distinguish between relevant (avoidable) and irrelevant (unavoidable) costs and provide examples of each type of cost. *(pp. 35–37)*

2.10 Explain the meaning of the term 'sunk cost'. *(p. 37)*

2.11 Distinguish between incremental and marginal costs. *(p. 38)*

2.12 What is an opportunity cost? Give some examples. *(pp. 37–38)*

2.13 Distinguish between job costing and process costing. *(p. 39)*

2.14 Explain responsibility accounting. *(p. 40)*

Review problems

2.15 Classify each of the following as being usually fixed (F), variable (V), semi-fixed (SF) or semi-variable (SV):

(a) direct labour;
(b) depreciation of machinery;
(c) factory rental;
(d) supplies and other indirect materials;
(e) advertising;
(f) maintenance of machinery;
(g) factory manager's salary;
(h) supervisory personnel;
(i) royalty payments.

2.16 Which of the following costs are likely to be controllable by the head of the production department?

(a) price paid for materials;
(b) charge for floor space;
(c) raw materials used;
(d) electricity used for machinery;
(e) machinery depreciation;
(f) direct labour;
(g) insurance on machinery;
(h) share of cost of industrial relations department.

2.17 If actual output is lower than budgeted output, which of the following costs would you expect to be lower than the original budget?

A Total variable costs
B Total fixed costs
C Variable costs per unit
D Fixed costs per unit

ACCA Foundation Paper 3

2.18 Which ONE of the following costs cound NOT be classified as a production overhead cost in a food processing company?

A The cost of renting the factory building.
B The salary of the factory manager.
C The depreciation of equipment located in the materials store.
D The cost of ingredients.

CIMA Management Accounting Fundamentals

2.19 The following data relate to two output levels of a department:

Machine hours	17 000	18 500
Overheads	£246 500	£251 750

The variable overhead rate per hour is £3.50. The amount of fixed overheads is:

A £5250
B £59 500
C £187 000
D £246 500

CIMA Stage 1

2.20 Prime cost is:

A all costs incurred in manufacturing a product;
B the total of direct costs;
C the material cost of a product;
D the cost of operating a department.

CIMA Stage 1

2.21 A direct cost is a cost which:

A is incurred as a direct consequence of a decision;
B can be economically identified with the item being costed;
C cannot be economically identified with the item being costed;
D is immediately controllable;
E is the responsibility of the board of directors.

CIMA Stage 2

2.22 Which of the following would be classed as indirect labour?

A assembly workers in a company manufacturing televisions;
B a stores assistant in a factory store;
C plasterers in a construction company;
D an audit clerk in a firm of auditors.

CIMA Stage 1 Cost Accounting

2.23 Fixed costs are conventionally deemed to be:

A constant per unit of output;
B constant in total when production volume changes;
C outside the control of management;
D those unaffected by inflation.

CIMA Stage 1 Cost Accounting

2.24 Prepare a report for the Managing Director of your company explaining how costs may be classified by their behaviour, with particular reference to the effects both on total and on unit costs. Your report should

(i) say why it is necessary to classify costs by their behaviour, and
(ii) be illustrated by sketch graphs within the body of the report.

(15 marks)
CIMA Stage 1 Accounting

2.25 Describe three different methods of cost classification and explain the utility of each method.

(11 marks)
ACCA Level 1 Costing

2.26 Cost classifications used in costing include:

(i) period costs
(ii) product costs
(iii) variable costs
(iv) opportunity costs

Required:

Explain each of these classifications, with examples of the types of costs that may be included.

(17 marks)
ACCA Level 1 Costing

2.27 (a) Describe the role of the cost accountant in a manufacturing organization.
(8 marks)

(b) Explain whether you agree with each of the following statements:
(i) 'All direct costs are variable.'
(ii) 'Variable costs are controllable and fixed costs are not.'
(iii) 'Sunk costs are irrelevant when providing decision making information.'

(9 marks)
(Total 17 marks)
ACCA Level 1 Costing

2.28 'Cost may be classified in a variety of ways according to their nature and the information needs of management.' Explain and discuss this statement, illustrating with examples of the classifications required for different purposes.

(22 marks)
ICSA Management Accounting

2.29 It is commonly suggested that a management accounting system should be capable of supplying different measures of cost for different purposes. You are required to set out the main types of purpose for which cost information may be required in a business organization, and to discuss the alternative measures of cost which might be appropriate for each purpose.

ICAEW Management Accounting

2.24 Prepare a report for the Managing Director of your company explaining how costs may be classified by their behaviour, with particular reference to the effects both on total and on unit costs. Your report should

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(ii) 'Variable costs are controllable and fixed costs are not.'
(iii) 'Sunk costs are irrelevant when providing decision making information.'

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2.28 'Cost may be classified in a variety of ways according to their nature and the information needs of management.' Explain and discuss this statement, illustrating with examples of the classifications required for different purposes.

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ICAEW Management Accounting

2.33 Sunk and opportunity costs for decision-making

Mrs Johnston has taken out a lease on a shop for a down payment of £5000. Additionally, the rent under the lease amounts to £5000 per annum. If the lease is cancelled, the initial payment of £5000 is forfeit. Mrs Johnston plans to use the shop for the sale of clothing, and has estimated operations for the next twelve months as follows:

	(£)	(£)
Sales	115 000	
Less Value-added tax (VAT)	15 000	
Sales Less VAT		100 000
Cost of goods sold	50 000	
Wages and wage related costs	12 000	
Rent including the down payment	10 000	
Rates, heating, lighting and insurance	13 000	
Audit, legal and general expenses	2 000	
		87 000
Net profit before tax		13 000

In the figures no provision has been made for the cost of Mrs Johnston but it is estimated that one half of her time will be devoted to the business. She is undecided whether to continue with her plans, because she knows that she can sublet the shop to a friend for a monthly rent of £550 if she does not use the shop herself.

You are required to:

(a) (i) explain and identify the 'sunk' and 'opportunity' costs in the situation depicted above;

(ii) state what decision Mrs Johnston should make according to the information given, supporting your conclusion with a financial statement;

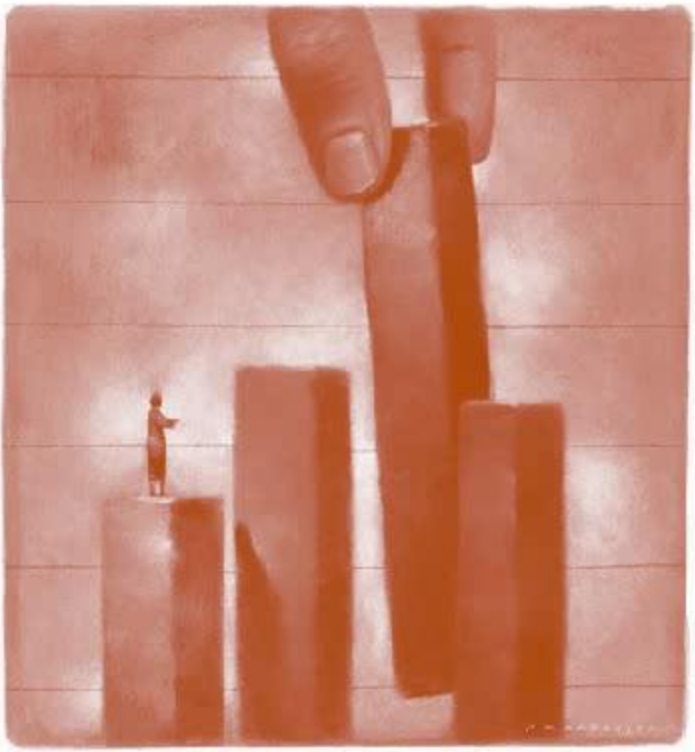
(11 marks)

(b) explain the meaning and use of 'notional' (or 'imputed') costs and quote *two* supporting examples.

(4 marks)

(Total 15 marks)

CIMA Foundation Cost Accounting 1



PART 2

Cost Accumulation for Inventory Valuation and Profit Measurement

3 Accounting for direct costs

4 Cost assignment for indirect costs

5 Accounting entries for a job costing system

6 Process costing

7 Joint and by-product costing

8 Income effects of alternative cost accumulation systems

This section focuses mainly on assigning costs to products to separate costs incurred during a period between costs of goods sold and the closing inventory valuation. The extent to which product costs accumulated for inventory valuation and profit measurement should be adjusted for meeting decision-making, cost control and performance measurement requirements is also briefly considered.

Chapter 3 is concerned with the recording procedures for direct labour and materials. This chapter also focuses on the materials control procedure, methods of establishing optimal stock levels and alternative approaches to scheduling materials requirements. Chapter 4 aims to provide you with an understanding of how costs are assigned to cost objects. In particular the chapter focuses on the assignment of indirect costs using traditional costing systems. In Chapter 5 the emphasis is on the accounting entries necessary to record transactions within a job costing system. The issues relating to a cost accumulation procedure for a process costing system are described in Chapter 6. This is a system that is applicable to industries that produce many units of the same product during a particular period. In Chapter 7 the problems associated with calculating product costs in those industries that produce joint and

by-products are discussed. The final chapter in this section is concerned with the alternative accounting methods of assigning fixed manufacturing overheads to products and their implications for profit measurement and inventory valuation.



Accounting for direct costs

3

In the previous chapter it was pointed out that labour and material costs can be categorized as either direct or indirect costs. You should be able to recall that direct costs are those costs that can be specifically and exclusively identified with a particular cost object whereas indirect costs cannot be identified with a particular cost object. In this, and the next five chapters, we shall assume products, services or customers' orders are the cost objects.

You will see in this chapter that the assignment of direct labour and materials to cost objects merely involves the implementation of suitable clerical/computer procedures to identify the quantity and prices of the resources consumed. At several stages throughout the chapter it will be pointed out that indirect labour and material costs are classified as overheads and the costs are assigned to overhead accounts classified

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- distinguish between payroll and labour cost accounting;
- describe the materials recording procedure;
- explain the accounting treatment of holiday pay, overtime premiums, employment costs, idle time, stores losses and delivery and materials handling costs;
- distinguish between first in, first out (FIFO), last in, first out (LIFO) and average cost methods of stores pricing
- justify which costs are relevant and should be included in the calculation of the economic order quantity (EOQ);
- calculate the EOQ using the formula and tabulation methods;
- describe the ABC classification method;
- describe materials requirement planning (MRP) systems;
- outline the main features of just-in-time systems.

by the type and location of expense. For example, where workers are unoccupied for short periods of time it will be recommended that the costs should be charged to an idle time overhead account for each department. In some situations, indirect labour and materials costs may not be easily identifiable with a particular department and the costs will be assigned to an appropriate overhead account for the business unit as a whole. For example, you will see that materials handling expenses are charged to a material handling expenses overhead account for the whole business unit since it is not possible to identify the costs with a particular department.

Indirect labour and material costs are assigned to overhead accounts classified by type and location of expense for cost control purposes so that management can monitor such costs and prioritize areas for cost reduction. In addition, manufacturing indirect labour and material costs must be assigned to products for inventory valuation purposes. At this stage you should note that the processes of accumulating indirect costs described in this chapter enables the costs to be more accurately allocated to products. However, the mechanisms that can be used to allocate the indirect costs from overhead accounts to products will not be explained until the next chapter.

The emphasis throughout this chapter is on how labour and materials costs that have already been incurred should be accumulated for allocating costs between costs of goods sold and inventories for internal and external profit reporting purposes. For decision-making the emphasis is on using future costs rather than past costs, so the accumulation of past costs is generally not relevant for decision-making. For example, many companies obtain customers' orders by submitting bids or quotations, which, if accepted become the agreed selling prices. The assignment of actual costs incurred may provide useful feedback information on the accuracy of the bids, and help to improve the accuracy of future bids, but past costs are normally not directly used for decision-making. Exceptions do exist, however, such as garages that charge for repairs on the basis of actual costs incurred. In these circumstances, the approaches described in this chapter can represent a direct input for determining the selling prices.

An understanding of the process of accounting for labour and materials requires a knowledge of the appropriate recording procedures and documentation. To simplify the presentation, and help you understand the recording procedures, manual clerical procedures are described. You should note, however, that in most organizations the recording procedures are computerized. Nevertheless, the basic principles described in this chapter still apply.

Finally, besides focusing on accounting for labour and materials this chapter also describes the materials control procedure, methods of establishing optimal stock levels and alternative approaches to scheduling materials requirements.

Accounting for labour costs

Accounting for labour costs can be divided into the following two distinct phases:

1. Computations of gross pay for each employee and calculation of payments to be made to employees, government, pension funds etc. (i.e. **payroll accounting**).
2. Allocation of labour costs to cost objects such as products or services, individual customers' orders and overhead accounts (i.e. **labour cost accounting**).

Payroll accounting

Payroll accounting requires the provision of information relating to an employee's attendance time, details of absenteeism, hourly rates of pay, and details of various deductions such as tax and National Insurance. **Clock cards** or absenteeism reports provide the basic information for the calculation of attendance time, and the employee's personal record card provides details of the various deductions. Where incentive payment systems are in operation, **piecework tickets** contain details of the number of items produced by each employee, and this is multiplied by the rate per item to give the total weekly wage. Where **bonus schemes** are in operation, the total payment will be based on an attendance time (the time rate wage) plus a bonus. The time rate wage is obtained from the clock card and the bonus details from the job card. Under a bonus scheme, a set time is allowed for each operation and a bonus is paid based on the proportion of time that is saved. An illustration of a bonus system is given in Example 3.1.

In the situation described in Example 3.1 the time allowed will previously have been recorded on the job card, and the actual time taken will be entered on the card when the operation is completed. The bonus can then be calculated and recorded on the employee's record card, which becomes the basis for determining the total weekly bonus to be included on the payroll. In most organizations the payroll accounting function will be computerized.

You should note that the objective of an incentive scheme is to benefit both the employer and employee. Consider a situation where an employee is paid £8 per hour and in one hour produces 10 units. The average labour cost per unit will be £0.80. To stimulate production, a piecework system is introduced where workers are paid £0.70 per unit produced. Assuming that this results in an increase in productivity to 12 units per hour, the hourly rate would increase to £8.40 (12 × £0.70). The overall effect is that there is an increase in the hourly rate of the employee and a reduction in the labour cost per unit produced for the employer (from £0.80 to £0.70).

EXAMPLE 3.1

The time allowed for a specific operation is 20 hours and the actual time taken by an employee was 16 hours. A bonus scheme is in operation where employees receive a bonus of 50% of the time saved. The hourly wage rate is £8 per hour.

The employee, having worked for 16 hours, will receive a time rate wage of £128 (16 hours at £8) plus a bonus of £16 (50% of 4 hours saved at £8 per hour).

Labour cost accounting

The objective of labour cost accounting is to record the amount of time that employees have taken on various activities. The time spent on providing a service to a specific customer, or manufacturing a specific product, is recorded on source documents, such as **time sheets** or **job cards**. Details of the customer's account number, job number or the product's code are also entered on these documents. The employee's hourly rate of pay is then entered so that the direct labour cost for the employee can be assigned to the appropriate cost object. For indirect labour costs the same procedure applies with the overhead account number to which the costs should be assigned being entered on the source documents.

Sometimes productive workers will be unoccupied for short periods and **idle time cards** are used to record the amount of idle or waiting time incurred. The amount of idle time is costed at the hourly wage rate and charged to an idle time overhead account for each department. An entry should be made on the card indicating the reasons for the idle time. Periodically, a report should be compiled for each department, showing a breakdown of the idle time and the proportion that it represents of recorded direct labour hours. In many organizations the recording procedures for accounting for labour will be computerized and the source documents will only exist in the form of computer records.

Some categories of labour, such as general labourers or supervision, may be engaged on numerous activities and it would not be feasible to record minute amounts of time on each activity. The labour costs of these employees should be derived from payroll details and charged to departmental overhead accounts for supervision or general labour. The procedure for accounting for overheads is explained in the next chapter.

Accounting treatment of various labour cost items

Holiday pay, overtime and shift premiums

Holiday pay received by employees whose labour cost is normally regarded as direct should be charged to activities by means of an inflated hourly rate. For example, if the employee is normally paid £8 per hour for a 40-hour week and is entitled to six weeks annual holiday he or she will receive a total of £1920 holiday pay (six weeks at £320 per week). Assuming that the employee works the remaining 46 weeks, the attendance time will amount to 1840 hours (46 weeks at 40 hours per week). Dividing £1920 by 1840 hours gives an addition of approximately £1.04 per hour to the employee's hourly wage rate to ensure that the holiday pay is recovered. The advantage of this approach is that holiday pay is treated as a direct labour cost.

Overtime premiums and **shift-work premiums** are included as part of overheads. If overtime premiums are charged directly to products/services or customers' orders undertaken during the overtime or night-shift period, they will bear higher costs than those produced during a regular working week. Overtime and night-shift work is usually necessitated by a generally high level of activity, not by specific products or customers. It is therefore inappropriate to record activities undertaken during overtime or night hours as being more costly than their counterparts undertaken during, say, a regular eight-hour day. If, however, the overtime or shift premiums are a direct result of a customer's urgent request for the completion of the order and not due to the general pressure of work, then the overtime or shift premiums should be charged directly to the customer. It is important that overtime and shift premiums are also analysed by departments for cost control purposes.

Let us now examine the comments made in the preceding paragraph with the aid of a simple illustration. Consider a situation where an employee is paid time and a half for weekly hours worked in excess of 40 hours. Assume that the employee works for 50 hours and that the 10 hours of overtime were spent on a particular activity. The hourly wage rate is £8. The employee's weekly wage will be calculated as follows:

Normal time rate wage: 50 hours at £8	£400
Overtime premium (1/2 × 10 hours at £8)	£40
	£440

The normal time rate wage will be allocated to the activities on which the employee was engaged during the period, but if the overtime was a result of demand exceeding productive capacity, it would be unreasonable to charge the overtime premium to the particular activity merely because it was scheduled to be produced during the overtime period. In such circumstances it would be preferable to charge the overtime premium to the appropriate overhead account, the total of which would be apportioned to all activities worked on during the period.

Employment costs

In addition to the wage and salary payments to employees, the employer will incur a number of other costs that are incidental to their employment. These costs include such items as the employer's share of National Insurance contributions and pension fund contributions. Some firms record employment costs as overheads, but it is preferable to calculate an average hourly rate for employment costs and add this to the hourly wage rate paid to the employees. For example, the employer may be responsible for employment costs of £40 for an operative who is paid £8 per hour for a 40-hour week. Here we can establish that the employment costs are £1 per hour and this cost can be added to the hourly wage rate of £8 per hour, giving a total rate of £9 per hour. This approach is conceptually preferable to the alternative of charging the £40 to an overhead account, since employment costs are a fundamental part of acquiring labour services.

Materials recording procedure

According to a survey by Drury and Tayles (2000) of 176 UK organizations the cost of direct materials represented the dominant costs in manufacturing organizations, averaging 51% of total costs for the responding organizations within the manufacturing sector. The accounting and control of materials is therefore of vital importance in manufacturing organizations. In the remainder of this chapter the mechanisms for recording and controlling materials are explained. Because of the importance to the manufacturing sector the focus is mainly on manufacturing organizations but the materials recording procedure that is described is also applicable to non-manufacturing organizations. The materials recording procedure involves the following stages:

- storage of materials;
- purchase of materials;
- receipt of materials;
- issue of materials;
- assigning the cost of materials to cost objects.

To simplify the presentation, and help you understand the recording procedures, the following sections describe the clerical procedures for each of the above stages. You should note, however, that in most organizations the recording procedure is computerized using barcoding and other forms of on-line information recording. The source documents that are described and illustrated are likely to exist only in the form of computer records.

Storage of materials

In a manufacturing organization the stores department will be responsible for ensuring that optimal stock levels are maintained for each item of material in stock. Thus, to control the quantity of stocks held, adequate records must be maintained for each stores item. When items of materials have reached their re-order point a **purchase requisition** is initiated requesting the purchase department to obtain the re-order quantity from an appropriate supplier. Methods that are used for establishing optimum stock levels, re-order points and re-order quantities will be explained later in this chapter.

Purchase of materials

Upon the receipt of a purchase requisition, purchasing department staff will select an appropriate supplier based on their expert knowledge, and then complete a **purchase order** requesting that the supplier supply the materials listed on the order. A copy of the purchase order is sent to the receiving section within the stores department for checking with the goods when they arrive.

Receipt of materials

When the goods are received by the receiving section they are inspected and checked with the supplier's delivery note and a copy of the purchase order. The receiving section then lists the materials received on a **goods received note** (GRN) and forwards copies of the GRN to the purchasing and accounting departments. The purchasing department will record that the order has been completed, and the accounting department will check the GRN with the supplier's invoice to ensure that payment is made only in respect of goods actually received. The department will also use the invoice to price each of the items listed on the GRN. The GRN is the source document for entering details of the items received in the receipts column of the appropriate **stores ledger account**. An illustration of a stores ledger account is provided in Exhibit 3.1. This document is merely a record of the quantity and value of each individual item of material stored by the organization.

Issue of materials

The formal authorization for the issue of materials is a **stores requisition**. The type and quantity of materials issued are listed on the requisition. This document also contains details of either the customer's order number, product/service code or overhead account for which the materials are required. Exhibit 3.2 provides an illustration of a typical stores requisition. Each of the items listed on the materials requisition are priced from the information recorded in the receipts column of the appropriate stores ledger account. The information for each of the items listed on the stores requisition is then recorded in the issues column of the appropriate stores ledger account and a balance of the quantity and value is calculated for each item of material.

EXHIBIT 3.1

A stores ledger account

Stores ledger account

Material: ..... Code: .....

Maximum quantity: .....

Minimum quantity: .....

Date	Receipts				Issues				Stock		
	GRN no.	Quantity	Unit price (£)	Amount (£)	Stores req. no.	Quantity	Unit price (£)	Amount (£)	Quantity	Unit price (£)	Amount (£)

EXHIBIT 3.2

A stores requisition

Stores requisition No.

Material required for:
(Product code or overhead account)

Department:

Date:

[Quantity]	Description	Code no.	Weight	Rate	£	[Notes]
Departmental Head						

Assigning the cost of materials to cost objects

The total cost of the items of material listed on the stores requisition is assigned to the appropriate customer's account number, overhead account or product or service code. The details on the material requisition thus represent the source information for assigning the cost of the materials to the appropriate cost object. Thus the accounting entries required for an issue of materials involve:

1. Reducing the value of raw materials stocks by recording the values issued in the issues column of the appropriate stores ledger account.
2. Assigning the cost of the issues to the appropriate customer's order number, product/service code or overhead account.

Pricing the issues of materials

A difficulty that arises with material issues is the cost to associate with each issue. This is because the same type of material may have been purchased at several different prices. Actual cost can take on several different values, and some method of pricing material issues must be selected. Consider the situation presented in Example 3.2.

EXAMPLE 3.2

On 5 March Nordic purchased 5000 units of materials at £1 each. A further 5000 units were purchased on 30 March at £1.20 each. During April, 5000 units were issued to job Z. No further issues were made during April and you are now preparing the monthly accounts for April.

There are three alternative methods that you might consider for calculating the cost of materials issued to job Z which will impact on both the cost of sales and the inventory valuation that is incorporated in the April monthly profit statement and balance sheet. First, you can assume that the first item received was the first item to be issued, that is **first in, first out (FIFO)**. In the example the 5000 units issued to job Z would be priced at £1 and the closing inventory would be valued at £6000 (5000 units at £1.20 per unit).

Secondly, you could assume that the last item to be received was the first item to be issued, that is, **last in, first out (LIFO)**. Here a material cost of £6000 (5000 units at £1.20 per unit) would be recorded against the cost of job Z and the closing inventory would be valued at £5000 (5000 units at £1 per unit).

Thirdly there may be a strong case for issuing the items at the **average cost** of the materials in stock (i.e. £1.10 per unit). With an average cost system the job cost would be recorded at £5500 and the closing inventory would also be valued at £5500. The following is a summary of the three different materials pricing methods relating to Example 3.2:

	Cost of sales (i.e. charge to job Z) £	Closing inventory £	Total costs £
First in, first out (FIFO)	5000 (5000 × £1)	6000 (5000 × £1.20)	11 000
Last in, first out (LIFO)	6000 (5000 × £1.20)	5000 (5000 × £1)	11 000
Average cost	5500 (5000 × £1.10)	5500 (5000 × £1.10)	11 000

FIFO appears to be the most logical method in the sense that it makes the same assumption as the physical flow of materials through an organization; that is, it is assumed that items received first will be issued first. During periods of inflation, the earliest materials that have the lowest purchase price will be issued first. This assumption leads to a lower cost of sales calculation, and therefore a higher profit than would be obtained by using either of the other methods. Note also that the closing inventory will be at the latest and therefore higher prices. With the LIFO method the latest and higher prices are assigned to the cost of sales and therefore

lower profits will be reported, compared with using either FIFO or average cost. The value of the closing inventory will be at the earliest and therefore lower prices. Under the average cost method, the cost of sales and the closing inventory will fall somewhere between the values recorded for the FIFO and LIFO methods.

LIFO is not an acceptable method of pricing for taxation purposes in the UK, although this does not preclude its use provided that the accounts are adjusted for taxation purposes. The UK Statement of Standard Accounting Practice (SSAP9) and the International Accounting Standard (IAS2) on inventory valuation, however, state that LIFO does not bear a reasonable relationship to actual costs obtained during the period, and imply that this method is inappropriate for external reporting. In view of these comments, the FIFO or the average cost method should be used for external financial accounting purposes. Instead of using FIFO or average cost for inventory valuation and profit measurement many organizations maintain their inventories at standard prices using a standard costing system. With a standard costing system the process of pricing material issues is considerably simplified. We shall look at standard costing in detail in Chapter 18.

The above discussion relates to pricing the issue of materials for internal and external profit measurement and inventory valuation. For decision-making the focus is on future costs, rather than the allocation of past costs, and therefore the different methods of pricing materials is not normally an issue.

The aim so far in this section has been to provide you with a simplistic example, in the form of Example 3.2, to provide you with an understanding of the implications of the three different methods of stores pricing. In practice pricing stores issues is likely to be more complex than the situation presented in Example 3.2. To ensure that you can price stores issues in more complex situations you should now refer to Example 3.3 and then examine each of the entries in stores ledger accounts for the three different pricing methods that are presented in Exhibit 3.3. Do remember, however, that in practice computer programs exist for pricing stores issues by the chosen method so it is most unlikely that the process will be carried out manually.

EXAMPLE 3.3

The purchase and issue of a raw material by the Midshire Water Authority for a five month period were as follows:

1 July	Received	2000 units at £10 per unit
9 July	Received	520 units at £10.50 per unit
18 July	Issued	1400 units
5 August	Received	800 units at £11.50 per unit
22 August	Received	600 units at £12.50 per unit
15 September	Issued	1240 units
14 October	Issued	480 units
8 November	Received	1000 units at £11 per unit
24 November	Issued	760 units

There was no opening stock of the raw material. You are required to prepare the stores ledger accounts when issues are priced, respectively, according to the FIFO, LIFO and average cost methods. Please refer to Exhibit 3.3 for the answer.

EXHIBIT 3.3

Pricing stores issues for the Midshire Water Authority

Stores ledger account – **FIFO method**

Material: ..... Code: ..... Maximum quantity: .....
Minimum quantity: .....

Date	Receipts				Issues				Stock		
	GRN no.	Quantity	Unit price (£)	Amount (£)		Quantity	Unit price (£)	Amount (£)	Quantity	Unit price (£)	Amount (£)
July 1		2000	10.00	20 000					2000		20 000
9		520	10.50	5 460					2520		25 460
18						1400	10.00	14 000	1120		11 460
Aug 5		800	11.50	9 200					1920		20 660
Aug 22		600	12.50	7 500					2520		28 160
Sept 15					600		10.00				
					520		10.50				
					120	1240	11.50	12 840	1280		15 320
Oct 14						480	11.50	5 520	800		9 800
Nov 8		1000	11.00	11 000	200		11.50		1800		20 800
Nov 24					560	760	12.50	9 300	1040		11 500

The closing stock represents:

40 units at £12.50 per unit =	£ 500
1000 units at £11.00 per unit =	£11 000
	£11 500

Stores ledger account – **LIFO method**

Material: ..... Code: ..... Maximum quantity: .....
Minimum quantity: .....

Date	Receipts				Issues				Stock		
	GRN no.	Quantity	Unit price (£)	Amount (£)		Quantity	Unit price (£)	Amount (£)	Quantity	Unit price (£)	Amount (£)
July 1		2000	10.00	20 000					2000		20 000
9		520	10.50	5 460					2520		25 460
18					520		10.50				
					880	1400	10.00	14 260	1120		11 200
Aug 5		800	11.50	9 200					1920		20 400
Aug 22		600	12.50	7 500					2520		27 900
Sept 15					600		12.50				
					640	1240	11.50	14 860	1280		13 040
Oct 14					160		11.50				
					320	480	10.00	5 040	800		8 000
Nov 8		1000	11.00	11 000					1800		19 000
Nov 24						760	11.00	8 360	1040		10 640

The closing stock represents:

800 units at £10.00 per unit =	£ 8 000
240 units at £11.00 per unit =	£ 2 640
	£10 640

Stores ledger account – **average-cost method**

Material: ..... Code: ..... Maximum quantity: .....
Minimum quantity: .....

Date	Receipts					Issues			Stock		
	GRN no.	Quantity	Unit price (£)	Amount (£)	Stores req.	Quantity	Unit price (£)	Amount (£)	Quantity	Unit price (£)	Amount (£)
July 1		2000	10.00	20 000					2000	10.00	20 000
9		520	10.50	5 460					2520	10.1032	25 460
18						1400	10.1032	14 144	1120		11 316
Aug 5		800	11.50	9 200					1920	10.6854	20 516
Aug 22		600	12.50	7 500					2520	11.1175	28 016
Sept 15						1240	11.1175	13 785	1280		14 231
Oct 14						480	11.1175	5 536	800		8 895
Nov 8		1000	11.00	11 000					1800	11.0528	19 895
Nov 24						760	11.0528	8 400	1040		11 495

$$9\ \text{July} = \frac{£25\,460}{2520\ \text{units}} = £10.1032$$

$$22\ \text{August} = \frac{£28\,016}{2520\ \text{units}} = £11.1175$$

You should note in Exhibit 3.3 that with the FIFO method the issue of 1240 units on 15 September is at three different purchase prices. This is because 1400 units out of the earliest purchase of 2000 units have already been issued. The remaining 600 units are therefore the first items to be issued out of the 1240 units on 15 September. The next earliest purchase of 520 units is now issued, leaving a balance of 120 units to be issued from the purchase of 5 August. The closing stock consists of the final purchase for the period of 1000 units plus 40 units from the 22 August purchase that have not yet been issued.

Now refer to the LIFO method in Exhibit 3.3 and look at the issue of 480 units on 14 October. This issue includes the 160 units at the 5 August purchase price of £11.50 because all of the units from the latest purchase on 22 August have previously been issued, together with 640 units from the next latest purchase of 5 August. Only 160 units from the 5 August purchase are available for issue. The balance of 320 units issued is at £10 as all the previous later purchases have already been issued. Hence LIFO does not always ensure that the issues are at the latest purchase price. The closing stock consists of 240 units at the latest purchase price of £11 plus 800 units at the earliest purchase price of £10.

Finally, with the average cost method shown in the third section of Exhibit 3.3 you should note that each of the items are issued at the average cost per unit. This is calculated by dividing the total value of the material in stock by the total quantity in stock; after each new purchase. An illustration of the average unit cost calculations for the 9 July and 22 August purchases is shown in the third section of Exhibit 3.3. An important point to note with the average cost method is that each item is issued at the latest average price and this average price changes only when a new purchase is received.

Issues relating to accounting for materials

In this section three issues that relate to accounting for materials are examined. The issues relate to the treatment of:

1. stores losses;
2. materials delivery costs; and
3. materials handling costs.

Treatment of stores losses

To achieve accurate profit measurement, the clerical or computer record in respect of each item of materials in stock must be in agreement with the actual stock held. This means that the actual stock must be physically counted and compared with the clerical or computer record. For this to be done effectively, there must be either a **complete periodic stockcount** or some form of continuous stocktaking. The former refers to a situation where all the stores items are counted at one point in time, whereas the latter involves a sample of stores items being counted regularly on, say, a daily basis. If there is **continuous stocktaking** production is unlikely to be disrupted.

Sometimes it may be found that the actual stock level is different from the clerical or computer records. The reasons for this may be:

1. an entry having been made in the wrong stores ledger account;
2. the items having been placed in the wrong physical location;
3. arithmetical errors made when calculating the stores balance on the stores ledger when a manual system is operated;
4. theft of stock.

When a discrepancy arises the individual stores ledger accounts must be adjusted so that they are in agreement with the actual stock. Assume, for example, that the actual stock is less than the clerical or computer record. The quantity and value of the appropriate stores ledger account must be reduced and the difference charged to an overhead account for stores losses. The total amount charged to the stores losses overhead account should be allocated to cost objects based on the overhead procedure described in the next chapter.

Treatment of materials delivery costs

Ideally, delivery charges made by suppliers should be included as part of the purchase price of the materials so that these costs can be charged as direct costs. Wherever possible, materials should be charged directly to cost objects rather than being grouped as indirect costs and apportioned to cost objects. The delivery charge will normally be shown separately on the invoice for the consignment of materials delivered. When the invoice is for one kind of material only, there is no problem in accounting for the materials and the resulting total entered as a receipt for the appropriate item of material. When the delivery charge refers to several different types of material, the charge must be apportioned to each type of material delivered. Such an apportionment could be made according to either the value or the weight of the materials. Alternatively, the clerical work could be simplified by charging delivery costs to an overhead account and apportioning these costs as part of the overhead procedure described in the next chapter.

Treatment of materials handling costs

The term 'materials handling costs' refers to the expenses involved in receiving, storing, issuing and handling materials. Various approaches can be used to account for materials handling costs. They involve charging the costs to a materials handling overhead account and allocating these costs to cost objects based on the approaches described for traditional costing systems in the next chapter or those for activity-based costing systems described in Chapter 11. You can therefore defer studying accounting for materials handling costs to the next chapter. However, it is appropriate at this stage that you should be aware that some companies establish a separate **materials handling rate**. Consider, for example, a situation where the materials handling costs for a period were £1 million and the direct materials issued during the period were valued at £5 million. In this situation the materials handling cost could be allocated to cost objects (i.e. products, services or customers) at a materials handling rate of 20% of the cost of direct materials issued (£1 million/£5 million) thus resulting in the £1 million materials handling cost being charged to cost objects.

Quantitative models for the planning and control of stocks

Investment in stocks represents a major asset of most industrial and commercial organizations, and it is essential that stocks be managed efficiently so that such investments do not become unnecessarily large. A firm should determine its optimum level of investment in stocks – and, to do this, two conflicting requirements must be met. First, it must ensure that stocks are sufficient to meet the requirements of production and sales; and, secondly, it must avoid holding surplus stocks that are unnecessary and that increase the risk of obsolescence. The optimal stock level lies somewhere between these two extremes. Our objective in the following sections is to consider how economic order quantities and the levels at which stocks should be replenished can be derived.

Relevant costs for quantitative models under conditions of certainty

The relevant costs that should be considered when determining optimal stock levels consist of holding costs and ordering costs. **Holding costs** usually consist of the following:

1. opportunity cost of investment in stocks;
2. incremental insurance costs;
3. incremental warehouse and storage costs;
4. incremental material handling costs;
5. cost of obsolescence and deterioration of stocks.

The relevant holding costs for use in quantitative models should include only those items that will vary with the levels of stocks. Costs that will not be affected by changes in stock levels are not relevant costs. For example, in the case of warehousing and

storage only those costs should be included that will vary with changes in the number of units ordered. Salaries of storekeepers, depreciation of equipment and fixed rental of equipment and buildings are often irrelevant because they are unaffected by changes in stock levels.

To the extent that funds are invested in stocks, there is an opportunity cost of holding them. This opportunity cost is reflected by the required return that is lost from investing in stocks rather than some alternative investment. The opportunity cost should be applied only to those costs that vary with the number of units purchased. The relevant holding costs for other items such as material handling, obsolescence and deterioration are difficult to estimate, but we shall see that these costs are unlikely to be critical to the investment decision. Normally, holding costs are expressed as a percentage rate per pound of average investment.

Ordering costs usually consist of the clerical costs of preparing a purchase order, receiving deliveries and paying invoices. Ordering costs that are common to all stock decisions are not relevant, and only the incremental costs of placing an order are used in formulating the quantitative models.

The costs of acquiring stocks through buying or manufacturing are not a relevant cost to be included in the quantitative models, since the acquisition costs remain unchanged, irrespective of the order size or stock levels, unless quantity discounts are available. (For a discussion of how quantity discounts should be incorporated you should refer to Drury, 2004; ch. 25.) For example, it does not matter in terms of acquisition cost whether total annual requirements of 1000 units at £10 each are purchased in one 1000-unit batch, ten 100-unit batches or one hundred 10-unit batches; the acquisition cost of £10 000 will remain unchanged. The acquisition cost is not therefore a relevant cost, but the ordering and holding costs will change in relation to the order size, and these will be relevant for decision-making models.

Determining the economic order quantity

If we assume certainty, the optimum order will be determined by those costs that are affected by either the quantity of stocks held or the number of orders placed. If more units are ordered at one time, fewer orders will be required per year. This will mean a reduction in the ordering costs. However, when fewer orders are placed, larger average stocks must be maintained, which leads to an increase in holding costs. The problem is therefore one of trading off the costs of carrying large stocks against the costs of placing more orders. The optimum order size is the order quantity that will result in the total amount of the ordering and holding costs being minimized. This optimum order size is known as the **economic order quantity (EOQ)**; it can be determined by tabulating the total costs for various order quantities, by a graphical presentation or by using a formula. All three methods are illustrated using the information given in Example 3.4.

Tabulation method

It is apparent from Example 3.4 that a company can choose to purchase small batches (e.g. 100 units) at frequent intervals or large batches (e.g. 10 000 units) at infrequent intervals. The annual relevant costs for various order quantities are set out in Exhibit 3.4. You will see that the economic order quantity is 400 units. At this point the total annual relevant costs are at a minimum.

EXAMPLE 3.4

A company purchases a raw material from an outside supplier at a cost of £9 per unit. The total annual demand for this product is 40 000 units, and the following additional information is available.

	(£)	(£)
Required annual return on investment in stocks (10% × £9)	0.90	
Other holding costs per unit	0.10	
Holding costs per unit		1.00
Cost per purchase order:		
Clerical costs, stationery, postage, telephone etc.		2.00

You are required to determine the optimal order quantity.

EXHIBIT 3.4

Relevant costs for various order quantities

Order quantity	100	200	300	400	500	600	800	10 000
Average stock in units[a]	50	100	150	200	250	300	400	5 000
Number of purchase orders[b]	400	200	133	100	80	67	50	4
Annual holding costs[c]	£50	£100	£150	£200	£250	£300	£400	£5 000
Annual ordering cost	£800	£400	£266	£200	£160	£134	£100	£8
Total relevant cost	£850	£500	£416	£400	£410	£434	£500	£5 008

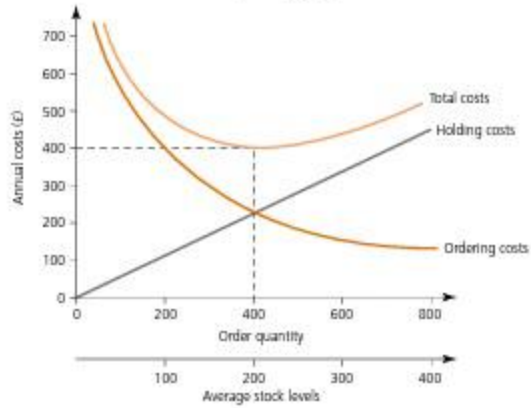
[a]If there are no stocks when the order is received and the units received are used at a constant rate, the average stock will be one-half of the quantity ordered. Even if a minimum safety stock is held, the average stock relevant to the decision will still be one-half of the quantity ordered, because the minimum stock will remain unchanged for each alternative order quantity.
[b]The number of purchase orders is ascertained by dividing the total annual demand of 40 000 units by the order quantity.
[c]The annual holding cost is ascertained by multiplying the average stock by the holding cost of £1 per unit.

Graphical method

The information tabulated in Exhibit 3.4 is presented in graphical form in Figure 3.1 for every order size up to 800 units. The vertical axis represents the relevant annual costs for the investment in stocks, and the horizontal axis can be used to represent either the various order quantities or the average stock levels; two scales are actually shown on the horizontal axis so that both items can be incorporated. You will see from the graph that as the average stock level or the order quantity increases, the holding cost also increases. Alternatively, the ordering costs decline as stock levels and order quantities are increased. The total cost line represents the summation of both the holding and the ordering costs.

Note that the total cost line is at a minimum for an order quantity of 400 units and occurs at the point where the ordering cost and holding cost curves intersect. That is, the economic order quantity is found at the point where the holding costs equal the ordering costs. It is also interesting to note from the graph (see also Exhibit 3.4) that the total relevant costs are not particularly sensitive to changes in the order quantity. For example, if you refer to Exhibit 3.4 you will see that a 25% change in the order

FIGURE 3.1 *Economic order quantity graph*



quantity from 400 units to either 300 or 500 units leads to an increase in annual costs from £400 to £410 or £416, an increase of 2.5% or 4%. Alternatively, an increase of 50% in the order quantity from 400 units to 600 units leads to an increase in annual costs from £400 to £434 or 8.5%.

Formula method

The economic order quantity can be found by applying a formula that incorporates the basic relationships between holding and ordering costs and order quantities. These relationships can be stated as follows: the number of orders for a period is the total demand for that item of stock for the period (denoted by D) divided by the quantity ordered in units (denoted by Q). The total ordering cost is obtained by multiplying the number of orders for a period by the ordering cost per order (denoted by O), and is given by the formula

$$\frac{\text{total demand for period}}{\text{quantity ordered}} \times \text{ordering cost per order} = \frac{DO}{Q}$$

Assuming that holding costs are constant per unit, the total holding cost for a period will be equal to the average stock for the period, which is represented by the quantity ordered divided by two ($Q/2$), multiplied by the holding cost per unit (denoted by H); it is therefore given by

$$\frac{\text{quantity ordered}}{2} \times \text{holding cost per unit} = \frac{QH}{2}$$

The total relevant cost (TC) for any order quantity can now be expressed as

$$TC = \frac{DO}{Q} + \frac{QH}{2}$$

We can determine a minimum for this total cost function by differentiating the above formula with respect to Q and setting the derivative equal to zero.[1] We then get the economic order quantity Q:

$$Q = \sqrt{\left(\frac{2DO}{H}\right)}$$

or

$$Q = \sqrt{\left(\frac{2 \times \text{total demand for period} \times \text{cost per order}}{\text{holding cost per unit}}\right)}$$

If we apply this formula to Example 3.4, we have

$$Q = \sqrt{\left(\frac{2 \times 40\,000 \times 2}{1}\right)} = 400 \text{ units}$$

Assumptions of the EOQ formula

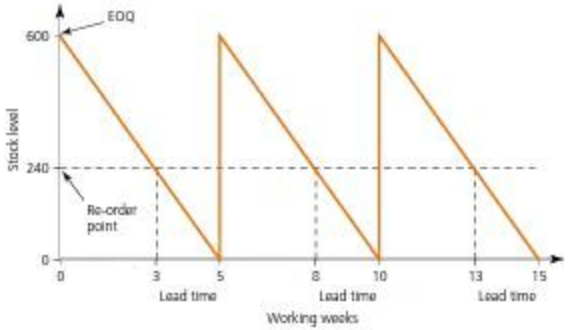
The calculations obtained by using the EOQ model should be interpreted with care, since the model is based on a number of important assumptions. One of these is that the holding cost per unit will be constant. While this assumption might be correct for items such as the funds invested in stocks, other costs might increase on a step basis as stock levels increase. For example, additional storekeepers might be hired as stock levels reach certain levels. Alternatively, if stocks decline, it may be that casual stores labour may be released once stocks fall to a certain critical level.

Another assumption that we made in calculating the total holding cost is that the average balance in stock was equal to one-half of the order quantity. If a constant amount of stock is not used per day, this assumption will be violated; there is a distinct possibility that seasonal and cyclical factors will produce an uneven usage over time. Despite the fact that much of the data used in the model represents rough approximations, calculation of the EOQ is still likely to be useful. If you examine Figure 3.1, you will see that the total cost curve tends to flatten out, so that total cost may not be significantly affected if some of the underlying assumptions are violated or if there are minor variations in the cost of predictions.

Determining when to place the order

To determine the point at which the order should be placed to obtain additional stocks (i.e. the **re-order point**), we must ascertain the time that will elapse between placing the order and the actual delivery of the stocks. This time period is referred to as the

FIGURE 3.2 *Fluctuations in stock levels under conditions of certainty*



lead time. In a world of certainty the re-order point will be the number of days/weeks lead time multiplied by the daily/weekly usage during the period. For materials, components and supplies the re-order point is the point in time when the purchase requisition is initiated and the order is sent to the supplier. For the finished goods stock of a manufacturer the re-order point is the level of finished goods stock at which the production order should be issued.

If we assume that an annual usage of a raw material is 6000 units and the weekly usage is constant then if there are 50 working weeks in a year, the weekly usage will be 120 units. If the lead time is two weeks, the order should be placed when stocks fall to 240 units. The economic order quantity can indicate how frequently the stocks should be purchased. For example, if the EOQ is 600 then, with an annual demand of 6000 units, ten orders will be placed every five weeks. However, with a lead time of two weeks, the firm will place an order three weeks after the first delivery when the stock will have fallen to 240 units (600 units EOQ less three weeks usage at 120 units per week). The order will then be repeated at five-weekly intervals. The EOQ model can therefore under certain circumstances be used to indicate when to replenish stocks and the amount to replenish. This process is illustrated in Figure 3.2.

Control of stocks through classification

In large firms it is quite possible for tens of thousands of different items to be stored. It is clearly impossible to apply the techniques outlined in this chapter to all of these. It is therefore essential that stocks be classified into categories of importance so that a firm can apply the most elaborate procedures of controlling stocks only to the most important items. The commonest procedure is known as the **ABC classification method**. This is illustrated in Exhibit 3.5.

The ABC method requires that an estimate be made of the total purchase cost for each item of stock for the period. The sales forecast is the basis used for estimating the

EXHIBIT 3.5
ABC Classification of stocks

Stage 1. For each item in stock multiply the estimated usage for a period by the estimated unit price to obtain the total purchase cost:

Item	Estimated usage	Unit price (£)	Total purchase cost (£)
1	60 000	1.00	60 000
2	20 000	0.05	1 000
3	1 000	0.10	100
4	10 000	0.02	200
5	100 000	0.01	1 000
6	80 000	2.00	160 000

(This list is continued until all items in stock are included.)

Stage 2. Group all the above items in descending order of purchase price and then divide into class A (top 10%), class B (next 20%) and then Class C (bottom 70%). The analysis might be as follows:

	Number of items in stock		Total cost	
	No	%	Amount (£)	%
Class A	1 000	10	730 000	73
Class B	2 000	20	190 000	19
Class C	7 000	70	80 000	8
	10 000	100	1 000 000	100

quantities of each item of stock to be purchased during the period. Each item is then grouped in decreasing order of annual purchase cost. The top 10% of items in stock in terms of annual purchase cost are categorized as A items, the next 20% as B items and the final 70% as C items. If we assume there are 10 000 stock items then the top 1000 items in terms of annual purchase costs will be classified as A items, and so on. In practice, it will be unnecessary to estimate the value of many of the 7000 C items, since their annual purchase cost will be so small it will be obvious that they will fall into the C category.

You will see from Exhibit 3.5 that 10% of all stock items (i.e. the A items) represents 73% of the total cost; 20% of the items (B items) represent 19% of the total cost; and 70% of the items (C items) represent 8% of the total cost. It follows that the greatest degree of control should be exerted over the A items, which account for the high investment costs, and it is the A category items that are most appropriate for the application of the quantitative techniques discussed in this chapter. For these items an attempt should be made to maintain low safety stocks consistent with avoiding high stockout costs. Larger orders and safety stocks are likely to be a feature of the C-category items. Normally, re-order points for these items will be determined on a subjective basis rather than using quantitative methods, the objective being to minimize the expense in controlling these items. The control of B-category items is likely to be based on quantitative methods, but they are unlikely to be as sophisticated as for the A-category items.

The percentage value of total cost for the A, B and C categories in Exhibit 3.5 is typical of most manufacturing companies. In practice, it is normal for between 10 and 15% of the items in stock to account for between 70 and 80% of the total value of purchases. At the other extreme, between 70 and 80% of the items in stock account for approximately 10%

of the total value. The control of stock levels is eased considerably it if is concentrated on that small proportion of stock items that account for most of the total cost.

Materials requirement planning

The discussion so far in this chapter has assumed that the replenishment of stocks and the determination of re-order points and order quantities (i.e the EOQ) for each item of material occurs independently of other activities. However, in complex manufacturing environments the demand for material purchases is dependent on the volume of the planned output of components and sub-components which include the raw materials that must be purchased. **Materials requirement planning (MRP)** originated in the early 1960s as a computerized approach for coordinating the planning of materials acquisition and production. The major feature of MRP is that it first involves an estimation of the quantity and timing of finished goods demanded and then uses this to determine the requirements for components/sub-components at each of the prior stages of production. This provides the basis for determining the quantity and timing of purchased materials and any bought-in components.

Figure 3.3 provides an overview of the approach. You can see that the top-level items represent three finished goods items (FG1, FG2 and FG3). The MRP system determines the requirements for each product into its components (or sub-components) and these are further separated into second, third and so on levels of sub-components, until at the lowest level of the hierarchy only purchased items (i.e. direct materials, DM) exist. For both FG1 and FG2 purchased raw materials are used to produce components before production of the end finished product. You should also note that in Figure 3.3 both FG1 and FG2 require the same sub-component (SC1), which in turn require the same direct materials (DM1).

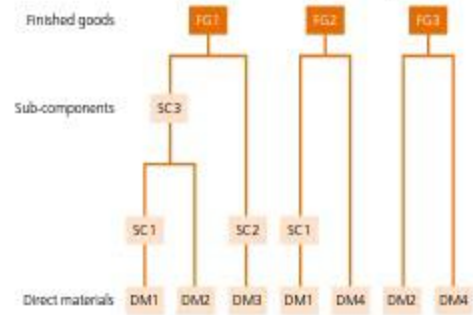
The operation of an MRP system involves the following:

1. A *master production schedule*: This schedule is the starting point for MRP. It specifies both the timing, and quantity demanded of each of the top-level finished goods items.
2. A *bill of materials file*, which specifies the components/sub-components and materials required for each finished product.
3. A *master parts file* containing planned lead times of all items to be purchased and internally produced components.
4. An *inventory file* for each item of material and component/sub-component containing details of the current balance available, scheduled orders and items allocated to production but not yet drawn from stocks.

The aim of MRP is to generate a planned coordinated schedule of materials requirements for a specified time period for each item of material after taking into account scheduled receipts, projected target stock levels and items already allocated to production but not yet drawn from stocks. The EOQ model can be used within MRP systems to determine economic quantity sizes to be purchased provided that the major assumption of the EOQ model of constant demand broadly applies.

Finally, you should note that after its introduction in the 1960s, materials requirement planning was later extended to the management of all manufacturing resources. In particular, it focuses on machine capacity planning and labour scheduling as well as materials requirement planning. This extended system is known as **manufacturing resource planning** or MRP II. The term MRP I is used to describe materials requirement planning.

FIGURE 3.3 *An overview of the structure of an MRP system*



Just-in-time systems

The success of Japanese firms in international markets in the 1980s generated interest among many Western companies as to how this success was achieved. The implementation of **just-in-time (JIT) methods** was considered to be one of the major factors contributing to this success. A JIT approach is best described as a philosophy of management dedicated to the elimination of **non-value-added activities**. A non-value-added activity is defined as an activity where there is an opportunity for cost reduction without reducing the customer's perceived usefulness of a product or service. In contrast, a **value-added activity** is an activity that customers perceive as adding usefulness to the product or service they purchase. The lead or cycle time involved in manufacturing and selling a product consists of process time, inspection time, move time, queue time and storage time. Of these five steps, only process time actually adds value to the product. All the other activities add cost but no value to the product, and are thus deemed non-value added processes within the JIT philosophy. According to Berliner and Brimson (1988), process time is less than 10% of total manufacturing lead time in many organizations in the USA. Therefore 90% of the manufacturing lead time associated with a product adds costs, but no value, to the product. By adopting a JIT philosophy and focusing on reducing lead times, it is claimed that total costs can be significantly reduced. The ultimate goal of JIT is to convert raw materials to finished products with lead times equal to processing times, thus eliminating all non-value added activities.

Rearrangement of the production process

The first stage in implementing JIT manufacturing techniques is to rearrange the production process away from a **batch production functional layout** towards a product layout using flow lines. With a functional plant layout products pass through a number of specialist departments that normally contain a group of similar machines. Products

are processed in large batches so as to minimize the set-up times when machine settings are changed between processing batches of different products. Batches move via different and complex routes through the various departments before they are completed. Each process normally involves a considerable amount of waiting time. The consequences of this complex routing process are high work in progress stock levels and long manufacturing cycle times.

The JIT solution is to reorganize the production process by dividing the many different products that an organization makes into families of similar products or components. All of the products in a particular group will have similar production requirements and routings. Production is rearranged so that each product family is manufactured in a well-defined production cell based on flow line principles. In a **product flow line** specialist departments containing *similar* machines no longer exist. Instead groups of *dissimilar* machines are organized into product or component family flow lines that function like an assembly line. For each product line the machines are placed close together in the order in which they are required by the group of products to be processed. Items in each product family can now move, one at a time, from process to process more easily, thereby reducing work in progress stocks and lead times.

JIT manufacturing aims to produce the right parts at the right time, only when they are needed, and only in the quantity needed. This philosophy has resulted in a **pull manufacturing system**, which means that parts move through the production system based on end-unit demand, focusing on maintaining a constant flow of components rather than batches of work-in-progress (WIP). With the pull system, work on components does not commence until specifically requested by the next process. JIT techniques aim to keep the materials moving in a continuous flow with no stoppages and no storage.

JIT purchasing arrangements

The JIT philosophy also extends to adopting **JIT purchasing techniques**, whereby the delivery of materials immediately precedes their use. By arranging with suppliers for more frequent deliveries, stocks can be cut to a minimum. JIT purchasing also normally requires suppliers to inspect materials before their delivery and guarantee their quality. This can result in considerable savings in material handling expenses. This improved service is obtained by giving more business to fewer suppliers and placing long-term purchase orders. Therefore the supplier has an assurance of long-term sales, and can plan to meet this demand. For JIT purchasing to be successful close cooperation with suppliers, including providing them with planned production schedules, is essential.

Companies that have implemented JIT purchasing techniques claim to have substantially reduced their investment in raw materials and work in progress stocks. Other advantages include significant quantity discounts, savings in time from negotiating with fewer suppliers and a reduction in clerical work from issuing long-term orders to a few suppliers rather than individual purchase orders to many suppliers.

Finally, you should note that the aim of JIT production and purchasing techniques is for production and purchases to immediately precede customer-required delivery dates. By seeking to ensure that production and purchases are timed to coincide with demand, the determination of economic order quantities and re-order points is no longer required.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Distinguish between payroll and labour cost accounting.**

  Payroll accounting is concerned with determining the gross pay for each employee and the associated payments in respect of all the employees relating to taxation and national insurance to the government and also payments to pension funds in respect of pensions deducted from employees plus the contributions made by the employer. Labour cost accounting is concerned with assigning the labour costs to cost objectives (e.g. products for direct labour costs and overhead accounts for indirect labour costs).

- **Describe the materials recording procedure.**

  When the materials are received the quantities and values are recorded in a separate stores ledger account for each item of material. The issues of materials are recorded on a stores requisition, which contains details of the job number product code or overhead account for which the materials are required. The information on the stores requisition is then recorded in the issues column of the appropriate stores ledger account and after each issue a balance of the quantity and value for each of the specific items of materials is calculated. The cost of each item of material listed on the stores requisition is assigned to the appropriate job number, product or overhead account. In practice this clerical process is likely to be computerized.

- **Explain the accounting treatment of holiday pay, overtime premiums, employment costs, idle time, stores losses and delivery and material handling costs.**

  You should check your understanding of the accounting treatment for these items by referring to the appropriate pages for these items in the key terms and concepts section at the end of this chapter.

- **Distinguish between first in, first out (FIFO), last in, first out (LIFO) and average cost methods of stores pricing.**

  Because the same type of materials may have been purchased at several different prices actual cost can take on several different values. Therefore an assumption must be made when pricing the materials used. FIFO assumes that the first item that was received in stock was the first item issued so the earlier purchase prices are used. LIFO assumes that the last item to be received is the first item to be issued resulting in the later purchase prices being used. The average cost method assumes that materials are issued at the average cost of materials in stock.

- **Justify which costs are relevant and should be included in the calculation of the economic order quantity (EOQ).**

  The relevant costs that should be considered when determining the EOQ consist of holding costs and ordering costs. The relevant holding costs should include only those items that will vary with the levels of stocks. Examples include the opportunity cost in terms of the return that is lost from the capital tied up in stocks and incremental insurance, materials handling and warehousing and storage costs. Ordering costs usually consist of the incremental clerical costs of preparing a purchase order, receiving deliveries and paying invoices. The purchase price is not normally a relevant cost since the cost per unit will be the same, irrespective of the order size. Note that special techniques can be applied to incorporate quantity discounts.

- **Calculate the EOQ using the tabulation and formula methods.**

  The tabulation method merely involves listing the ordering and holding costs for each potential order quantity over a selected period. The order costs are computed by multiplying the number of orders by the incremental cost per order. To compute the holding costs the average stock level is multiplied by the holding cost per unit. Assuming constant usage, average stock levels are derived by dividing the potential order quantities by 2. The computation of the EOQ using both methods was illustrated using Example 3.4.

- **Describe the ABC classification method.**

  The ABC method classifies stocks into categories of importance so that the most elaborate procedures of controlling stocks can be applied to the most important items. The ABC classification method requires that an estimate be made of the total purchase cost for each item in stock for a period. Each item is then grouped in decreasing order in terms of their purchase cost for the period. The top 10% of items in stock in terms of the purchase cost for the period are classified as 'A' items. The next 20% as 'B' items and the final 70% as 'C' items. It is generally found that the 'A' items can account for over 70% of the total purchase cost for a period. The most sophisticated procedures for planning and controlling stocks are applied to the 'A' items.

- **Describe materials requirement planning (MRP) systems.**

  The EOQ model assumes that the demand for each item of material occurs independently of other activities. However, in complex manufacturing environments the demand for material purchases is not independent. It is dependent on the volume of the planned output of components and sub-components which include the raw materials that must be purchased. Materials requirement planning (MRP) originated in the early 1960s as a computerized approach for coordinating the planning of materials acquisition and production. The major feature of MRP is that it first involves an estimation of the quantity and timing of finished goods demanded and then uses this to determine the requirements for components/sub-components at each of the prior stages of production. This provides the basis for determining the quantity and timing of purchased materials and any bought-in components. The aim of MRP is to generate a planned coordinated schedule of materials requirements for a specified time period for each item of material.

- **Outline the main features of just-in-time systems.**

  In recent years many companies have sought to eliminate and/or reduce the costs of non-value added activities by introducing just-in-time (JIT) systems. The aims of a JIT system are to produce the required items, at the required quality and in the required quantities, at the precise time they are required. In particular, JIT aims to eliminate waste by minimizing inventories and reducing cycle or throughput times (i.e. the time elapsed from when customers place an order until the time when they receive the desired product or service). Adopting a JIT manufacturing system involves moving from a batch production functional layout to a cellular flow line manufacturing system. The JIT philosophy also extends to adopting JIT purchasing techniques, whereby the delivery of materials immediately precedes their use. By arranging with suppliers for more frequent deliveries, stocks can be cut to a minimum. This improved service is obtained by giving more business to fewer suppliers and placing long-term purchase orders. For JIT purchasing to be successful, close cooperation with suppliers is essential.

Notes

1. The steps are as follows:

$$TC = \frac{DO}{Q} + \frac{QH}{2}$$

$$\frac{dTC}{dQ} = \frac{-DO}{Q^2} + \frac{H}{2}$$

$$\frac{dtC}{dQ} = 0 : \quad \frac{H}{2} - \frac{DO}{Q^2} = 0$$

$$HQ^2 = 2DO = 0$$

$$Q^2 = \frac{2DO}{H}$$

$$\textit{Therefore} \quad Q = \sqrt{\left(\frac{2\,DO}{H}\right)}$$

Key terms and concepts

ABC classification method (p. 70)
average cost (p. 60)
batch production functional layout (p. 73)
bonus scheme (p. 55)
clock card (p. 55)
complete periodic stockcount (p. 64)
continuous stocktaking (p. 64)
economic order quantity (EOQ) (p. 66)
first in, first out (FIFO) (p. 60)
goods received note (p. 58)
holding costs (p. 65)
holiday pay (p. 56)
idle time card (p. 56)
job card (p. 55)
just-in-time (JIT) methods (p. 73)
just-in-time (JIT) purchasing techniques (p. 74)
labour cost accounting (p. 54)
last in, first out (LIFO) (p. 60)
lead time (p. 70)
manufacturing resource planning (p. 72)
materials handling rate (p. 65)
materials requirement planning (MRP) (p. 72)
non-value added activity (p. 73)
ordering costs (p. 66)
overtime premium (p. 56)
payroll accounting (p. 54)
piecework ticket (p. 55)
product flow line (p. 74)
pull manufacturing system (p. 74)
purchase order (p. 58)
purchase requisition (p. 58)
re-order point (p. 69)
shift-work premium (p. 56)
stores ledger account (p. 58)
stores requisition (p. 58)
time sheet (p. 55)
value-added activity (p. 73)

Key examination points

Typical examination questions relating to the content of this chapter include questions on incentive schemes (including the calculation of bonuses), stores pricing and computations of the economic order, maximum, minimum and re-order quantities. Questions 3.29 and 3.30 are examples of typical examination questions relating to incentive schemes. Questions on stores pricing often require you to calculate the amount charged to products/production, to determine the stock valuation and discuss arguments for and against using each method. Question SM3.7 in the Students' Manual on the website is concerned with most aspects covered in this chapter relating to the computation of the economic order quantity and is typical of the type of examination

questions set on this topic. A common mistake that students make in computing the EOQ is to unitize fixed holding and ordering costs. The EOQ should be calculated using only variable costs. Also note that the purchase cost of materials should not be included in EOQ calculations. When the purchase cost per unit varies with the quantity ordered you should prepare a schedule of relevant costs for different order quantities. For an illustration of this approach, see Exhibit 3.4 in Chapter 3. Sometimes examination questions (see questions 3.26 and SM3.6c in the Students' Manual on the website) require you to calculate maximum, minimum and re-order levels. You should use the following formulae:

Re-order level = Maximum usage × maximum lead time
Maximum stock level = Re-order level – average usage during average lead time
Maximum stock level = Re-order level + EOQ – minimum usage for the minimum lead time



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in the parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

3.1 Describe the procedures involved in payroll labour cost accounting. *(pp. 55–56)*

3.2 Explain the accounting treatment for holiday pay, overtime payments and employment costs. *(pp. 56–57)*

3.3 Describe the materials recording procedure. *(p. 57)*

3.4 Explain the purpose of a stores ledger account. *(p. 58)*

3.5 Describe the first in, first out (FIFO), last in, first out (LIFO) and average cost methods of stores pricing. *(pp. 60–63)*

3.6 Explain the accounting treatment of stores losses and materials handling costs. *(pp. 64–65)*

3.7 What are holding costs? Provide some examples. *(pp. 65–66)*

3.8 What are ordering costs? Provide some examples. *(p. 66)*

3.9 What determines which holding and ordering costs should be included in the economic order quantity calculation? *(pp. 66)*

3.10 What are the assumptions underlying the economic order quantity? *(p. 69)*

3.11 Define lead time. *(p. 70)*

3.12 Explain what is meant by the re-order point. *(pp. 69–70)*

3.13 Describe the ABC classification method. What purposes does it serve? *(pp. 70–71)*

3.14 What are the main features of materials requirements planning? *(p. 72)*

3.15 What are the main features of just-in-time systems? *(pp. 73–74)*

Review problems

3.16 A machine operator is paid $10.20 per hour and has a normal working week of 35 hours. Overtime is paid at the basic rate plus 50%. If in week 7, the machine operator worked 42 hours, the overtime premium paid to the operator would be:

A $28.20 B $35.70 C $71.40 D $107.10

CIMA Management Accounting Fundamentals

3.17 An advertising agency uses a job costing system to calculate the cost of client contracts. Contract A42 is one of several contracts undertaken in the last accounting period. Costs associated with the contract consist of:

Direct materials $5 500
Direct expenses $14 500

Design staff worked 1020 hours on contract A42, of which 120 hours were overtime. One third of these overtime hours were worked at the request of the client who wanted the contract to be completed quickly. Overtime is paid at a premium of 25% of the basic wage of $24.00 per hour. The prime cost of contract A42 is

A $41 600 B $44 480 C $44 720 D $45 200

CIMA Management Accounting Fundamentals

3.18 **Which of the following statements is correct?**

A A stores ledger account will be updated from a goods received note only.
B A stores requisition will only detail the type of product required by a customer.
C The term 'lead time' is best used to describe the time between receiving an order and paying for it.
D To make an issue from stores authorization should be required.

ACCA Paper 1.2 – Financial Information for Management

3.19 The following relate to procedures for materials:

1. Check the goods received note
2. Raise a stores requisition note
3. Update the stores ledger account for the purchase
4. Raise a purchase order

What would be the correct order of the above when in the process of purchasing and using materials?

A 4, 2, 1, 3
B 2, 1, 3, 4
C 4, 1, 3, 2
D 1, 4, 3, 2

ACCA Paper 1.2 – Financial Information for Management

3.20 The effect of using the last in, first out (LIFO) method of stock valuation rather than first, in, first out (FIFO) method in a period of rising prices is:

A to report lower profits and a lower value of closing stock
B to report higher profits and a higher value of closing stock
C to report lower profits and a higher value of closing stock
D to report higher profits and a lower value of closing stock

CIMA Management Accounting Fundamentals

3.21 Using the first in, first out (FIFO) system for pricing stock issues means that when prices are rising:

A product costs are overstated and profits understated
B product costs are kept in line with price changes
C product costs are understated and profits understated
D product costs are understated and profits are overstated

CIMA Stage 1

3.22 E Ltd's stock purchases during a recent week were as follows:

Day	Price per unit ($)	Units purchased
1	1.45	55
2	1.60	80
3	1.75	120
4	1.80	75
5	1.90	130

There was no stock at the beginning of the week. 420 units were issued to production during the week. The company updates its stock records after every transaction.

(a) Using a first in, first out (FIFO) method of costing stock issues, the value of closing stock would be:

A $58.00 B $70.00 C $72.00 D $76.00

(b) If E Ltd changes to the weighted average method of stock valuation, the effect on closing stock value and on profit compared with the FIFO method will be

A Higher closing stock value and higher gross profit
B Lower closing stock value and higher gross profit
C Lower closing stock value and lower gross profit
D Higher closing stock value and lower gross profit

CIMA Management Accounting Fundamentals

3.23 A company values stocks using the weighted average value after each purchase. The following receipts and issues have been made with regards to materials for the last month:

Date	Receipts			Issues
	Units	£/unit	Valuation	Units
Brought forward	100	5	£500	
4th	150	5.50	£8.25	
16th				100
20th	100	6	£600	
21st				75

What is the value of the closing stock using this weighted average method?

A £1012.50
B £976.50
C £962.50
D £925.00

ACCA Paper 1.2 – Financial Information for Management

3.24 W plc uses the economic order quantity (EOQ) as part of its materials control policy. The objective of the EOQ is to ensure that:

A the company never runs out of stock except in exceptional circumstances
B the cost of being out of stock is minimized
C the combined cost of ordering and holding stock is minimized
D stock is purchased from suppliers are the cheapest price

CIMA Management Accounting Fundamentals

3.25 Moura uses the economic order quantity formula (EOQ) to establish its optimal reorder quantity for its single raw material. The following data relates to the stock costs:

Purchase price:	£15 per item
Carriage costs:	£50 *per order*
Ordering costs:	£5 *per order*
Storage costs:	10% of purchase price plus £0.20 per unit per annum

Annual demand is 4000 units.

What is the EOQ to the nearest whole unit?

A 153 units
B 170 units
C 485 units
D 509 units

ACCA Paper 1.2 – Financial Information for Management

3.26 A domestic appliance retailer with multiple outlets stocks a popular toaster known as the Autocrisp 2000, for which the following information is available:

Average sales	75 per day
Maximum sales	95 per day
Minimum sales	50 per day
Lead time	12–18 days
Re-order quantity	1750

(i) Based on the data above, at what level of stocks would a replenishment order be issued?

A 1050 B 1330 C 1710 D 1750

(ii) Based on the data above, what is the maximum level of stocks possible?

A 1750 B 2860 C 3460 D 5210

CIMA Stage 1 Cost Accounting

3.27 Which of the following is correct with regard to stocks?

(i) Stock-outs arise when too little stock is held.
(ii) Safety stocks are the level of units maintained in case there is unexpected demand.
(iii) A reorder level can be established by looking at the maximum usage and the maximum lead-time.

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

ACCA Paper 1.2 – Financial Information for Management

3.28 A company uses the Economic Order Quantity (EOQ) model to establish re-order quantities. The following information relates to the forthcoming period:

Order costs	£25 per order
Holding costs	10% of purchase price = £4/unit
Annual demand	20 000 units
Purchase price	£40 per unit
EOQ	500 units

No safety stocks are held.

What are the total annual costs of stock (i.e. the total purchase cost plus total order cost plus total holding cost)?

A £22 000
B £33 500
C £802 000
D £803 000

ACCA Paper 1.2 – Financial Information for Management

3.29 Calculation of earnings

(a) A company is proposing to introduce an incentive scheme into its factory.
Required:
Three advantages and three disadvantages of individual incentive schemes.

(6 marks)

(b) The company is undecided on what kind of scheme to introduce.
Required:
From the following information calculate for each employee his earnings, using:
(i) guaranteed hourly rates only (basic pay);
(ii) piecework, but with earnings guaranteed at 75% of basic pay where the employee fails to earn this amount;

(iii) premium bonus, in which the employee receives two-thirds of time saved in addition to hourly pay.

	Employees			
	A	B	C	D
Actual hours worked	38	36	40	34
Hourly rate of pay	£3	£2	£2.50	£3.60
Output (units) X	42	120	–	120
Y	72	76	–	270
Z	92	–	50	–

Standard time allowed (per unit):
X: 6 minutes; Y: 9 minutes; Z: 15 minutes
Each minute earned is valued at £0.05 for piecework calculation.

(16 marks)
(Total 22 marks)
AAT

3.20 Effect of an incentive scheme on company profits

You have been approached for your advice on the proposed introduction of an incentive scheme for the direct operatives in the final production department of a factory producing one standard product. This department, the Finishing Shop, employs 30 direct operatives, all of whom are paid £8 per hour for a basic 40-hour week, with a guaranteed wage of £320 per week. When necessary, overtime is worked up to a maximum of 15 hours per week per operative and is paid at time rate plus one-half. It is the opinion of the personnel manager that no more direct operatives could be recruited for this department.

An analysis of recent production returns from the Finishing Shop indicates that the current average output is approximately 6 units of the standard product per productive man-hour. The work study manager has conducted an appraisal of the working methods in the Finishing Shop and suggests that it would be reasonable to expect operatives to process 8 units of the product per man-hour and that a piecework scheme be introduced in which the direct operatives are paid £1.40 for each unit processed. It is anticipated that, when necessary, operatives would continue to work overtime up to the previous specified limit, although as the operatives would be on piecework no premium would be paid.

Next year's budgeted production for the factory varies from a minimum of 7000 units per week to a maximum of 12 000 units per week, with the most frequent budgeted weekly output being 9600 units. The expected selling price of the product next year is £11 per unit and the budgeted variable production cost of the incomplete product passed into the Finishing Shop amounts to £8 per unit. Variable production overheads in the Finishing Shop, excluding the overtime premium of the direct operatives, are budgeted to be £0.48 per direct labour hour worked, and it is considered that variable overheads do vary directly with productive hours worked. Direct material costs are not incurred by the Finishing Shop. The fixed overheads incurred by the factory amount in total to £9000 per week.

Stocks of work in progress and finished goods are not carried.

Required:

(i) Calculate the effect on the company's budgeted weekly profits of the proposed incentive scheme in the Finishing Shop. (Calculation should be to the nearest £.)

(15 marks)

(ii) Explain the reasons for the changes in the weekly budgeted profits caused by the proposed incentive scheme.

(7 marks)

ACCA Level 1 Costing

3.31 Calculation of EOQ

One of the components used by K Ltd is ordered from a specialist supplier. The daily usage for this component and the time between placing and receiving an order (the lead time) can vary as follows:

Maximum usage	750 per day
Average usage	580 per day
Minimum usage	450 per day
Maximum lead time	15 days
Average lead time	12 days
Minimum lead time	8 days

Calculate the number of units that can be ordered at the re-order level if, as a result of storage problems, the company cannot allow stock to rise above 15 000 units.

(3 marks)

CIMA Management Accounting Fundamentals

3.32 Calculation of number of orders and holding costs

N Ltd's Chief Executive believes the company is holding excessive stocks and has asked the Management Accountant to carry out an investigation. Information on the two stock items is given below:

Stock item	Purchase price $ per unit	Administration cost $ per order	Demand units	Holding cost per year % of purchase price
G	200	80	15 000 per year	13.33
H	25	28	2 800 per year	8.00

The company's stock ordering policy is based on the Economic Order Quantity (EOQ).

Required:

(a) Determine the number of orders per year that the company will place for item G

(3 marks)

(b) Determine the annual holding cost of the stock of item H

(3 marks)

CIMA Management Accounting Fundamentals

3.33 Calculation of EOQ

A business currently order 1000 units of product X at a time. It has decided that it may be better to use the Economic Order Quantity method to establish an optimal reorder quantity.

Information regarding stocks is given below:

Purchase price	£15/unit
Fixed cost per order	£200
Holding cost	8% of the purchase price per annum
Annual demand	12 000 units

Current annual total stock costs are £183 000, being the total of the purchasing, ordering and holding costs of product X.

Required:

(a) Calculate the Economic Order Quantity

(2 marks)

(b) Using your answer to (a) above calculate the revised annual total stock costs for product X and so establish the difference compared to the current ordering policy.

(4 marks)

ACCA Paper 1.2 – Financial Information for Management



Cost assignment for indirect costs

4

In Chapters 1 and 2 it was pointed out that companies need cost and management accounting systems to perform a number of different functions. In this chapter we are going to concentrate on two of these functions – they are (i) allocating costs between cost of goods sold and inventories for internal and external profit reporting and (ii) providing relevant decision-making information for distinguishing between profitable and unprofitable activities.

In order to perform the above functions a cost accumulation system is required that assigns costs to cost objects. The aim of this chapter is to provide you with an understanding of how costs are accumulated and assigned to cost objects. You should have remembered from Chapter 2 that a cost object is anything for which a separate measurement of cost is desired. Typical cost objects include products, services, customers and locations. In this chapter we shall either use the term cost object as a generic term or assume that products are the cost object. However, the same cost assignment principles can be applied to all cost objects.

We begin by explaining how the cost assignment process differs for direct and indirect costs.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- distinguish between cause-and-effect and arbitrary cost allocations;
- explain why different cost information is required for different purposes;
- describe how cost systems differ in terms of their level of sophistication;
- understand the factors influencing the choice of an optimal cost system;
- explain why departmental overhead rates should be used in preference to a single blanket overhead rate;
- construct an overhead analysis sheet and calculate cost centre allocation rates;
- justify why budgeted overhead rates should be used in preference to actual overhead rates;
- calculate and explain the accounting treatment of the under- over-recovery of overheads.

Assignment of direct and indirect costs

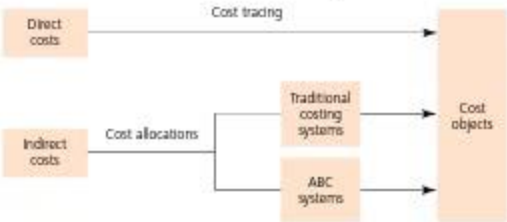
Costs that are assigned to cost objects can be divided into two categories – direct costs and indirect costs. Sometimes the term **overheads** is used instead of indirect costs. Direct costs can be accurately traced to cost objects because they can be specifically and exclusively traced to a particular cost object whereas indirect costs cannot. Where a cost can be directly assigned to a cost object the term **cost tracing** is used. In contrast, indirect costs cannot be traced directly to a cost object because they are usually common to several cost objects. Indirect costs are therefore assigned to cost objects using cost allocations.

A **cost allocation** is the process of assigning costs when a direct measure does not exist for the quantity of resources consumed by a particular cost object. Cost allocations involve the use of surrogate rather than direct measures. For example, consider an activity such as receiving incoming materials. Assuming that the cost of receiving materials is strongly influenced by the number of receipts then costs can be allocated to products (i.e. the cost object) based on the number of material receipts each product requires. The basis that is used to allocate costs to cost objects (i.e. the number of material receipts in our example) is called an **allocation base** or **cost driver**. If 20% of the total number of receipts for a period were required for a particular product then 20% of the total costs of receiving incoming materials would be allocated to that product. Assuming that the product was discontinued, and not replaced, we would expect action to be taken to reduce the resources required for receiving materials by 20%.

In the above illustration the allocation base is assumed to be a significant determinant of the cost of receiving incoming materials. Where allocation bases are significant determinants of the costs we shall describe them as **cause-and-effect allocations**. Where a cost allocation base is used that is not a significant determinant of its cost the term **arbitrary allocation** will be used. An example of an arbitrary allocation would be if direct labour hours were used as the allocation base to allocate the costs of materials receiving. If a labour-intensive product required a large proportion of direct labour hours (say 30%) but few material receipts it would be allocated with a large proportion of the costs of material receiving. The allocation would be an inaccurate assignment of the resources consumed by the product. Furthermore, if the product were discontinued, and not replaced, the cost of the material receiving activity would not decline by 30% because the allocation base is not a significant determinant of the costs of the materials receiving activity. Arbitrary allocations are therefore likely to result in inaccurate allocations of indirect costs to cost objects.

Figure 4.1 provides a summary of the assignment process. You can see that direct costs are assigned to cost objects using cost tracing whereas indirect costs are assigned using cost allocations. For accurate assignment of indirect costs to cost objects cause-and-effect allocations should be used. Two types of systems can be used to assign indirect costs to cost objects. They are **traditional costing systems** and **activity-based-costing (ABC) systems**. Traditional costing systems were developed in the early 1900s and are still widely used today. They rely extensively on arbitrary cost allocations. ABC systems only emerged in the late 1980s. One of the major aims of ABC systems is to use only cause-and-effect cost allocations. Both cost systems adopt identical approaches to assigning direct costs to cost objects. In this chapter we shall concentrate on traditional costing systems and ABC systems will be examined in Chapter 11.

FIGURE 4.1 *Cost allocations and cost tracing*



Different costs for different purposes

Manufacturing organizations assign costs to products for two purposes: first, for internal profit measurement and external financial accounting requirements in order to allocate the manufacturing costs incurred during a period between cost of goods sold and inventories; secondly, to provide useful information for managerial decision-making requirements. In order to meet financial accounting requirements, it may not be necessary to accurately trace costs to *individual* products. Consider a situation where a firm produces 1000 different products and the costs incurred during a period are £10 million. A well-designed product costing system should accurately analyse the £10 million costs incurred between cost of sales and inventories. Let us assume the true figures are £7 million and £3 million. Approximate but inaccurate *individual* product costs may provide a reasonable approximation of how much of the £10 million should be attributed to cost of sales and inventories. Some product costs may be overstated and others may be understated, but this would not matter for financial accounting purposes as long as the *total* of the individual product costs assigned to cost of sales and inventories was approximately £7 million and £3 million.

For decision-making purposes, however, more accurate product costs are required so that we can distinguish between profitable and unprofitable products. By more accurately measuring the resources consumed by products, or other cost objects, a firm can identify its sources of profits and losses. If the cost system does not capture sufficiently accurately the consumption of resources by products, the reported product costs will be distorted, and there is a danger that managers may drop profitable products or continue production of unprofitable products.

Besides different levels of accuracy, different cost information is required for different purposes. For meeting external financial accounting requirements, financial accounting regulations and legal requirements in most countries require that inventories should be valued at manufacturing cost. Therefore only manufacturing costs are assigned to products for meeting external financial accounting requirements. For decision-making non-manufacturing costs must be taken into account and assigned to products. Not all costs, however, may be relevant for decision-making. For example, depreciation of plant and machinery will not be affected by a decision to discontinue a product. Such costs were described in Chapter 2 as irrelevant and sunk for decision-making. Thus depreciation of plant must be assigned to products for inventory valuation but it should not be assigned for discontinuation decisions.

Maintaining a single or separate databases

Because different costs and different levels of accuracy are required for different purposes some organizations maintain two separate costing systems, one for decision-making and the other for inventory valuation and profit measurement. In a survey of 187 UK companies Drury and Tayles (2000) reported that 9% of the companies maintained two cost accumulation systems, one for decision-making and the other for inventory valuation. The remaining 91% of organizations maintained a costing system on a single database from which appropriate cost information was extracted to provide the required information for both decision-making and inventory valuation. When a single database is maintained only costs that must be assigned for inventory valuation are extracted for meeting financial accounting requirements, whereas for decision-making only costs which are relevant for the decision are extracted. Inventory valuation is not an issue for many service organizations. They do not carry inventories and therefore a costing system is not required for meeting inventory valuation requirements.

Where a single database is maintained cost assignments cannot be at different levels of accuracy for different purposes. In the late 1980s, according to Johnson and Kaplan (1987), most organizations were relying on costing systems that had been designed primarily for meeting external financial accounting requirements. These systems were designed decades ago when information processing costs were high and precluded the use of more sophisticated methods of assigning indirect costs to products. Such systems are still widely used today. They rely extensively on arbitrary cost allocations which may be sufficiently accurate for meeting external financial accounting requirements but not for meeting decision-making requirements. Johnson and Kaplan concluded that management accounting practices have followed and become subservient to meeting financial accounting requirements.

Cost–benefit issues and cost systems design

These criticisms resulted in the emergence of ABC in the late 1980s. Surveys in many countries suggest that between 20 and 30% of the surveyed organizations have implemented ABC systems. The majority of organizations therefore continue to operate traditional systems. Both traditional and ABC systems vary in their level of sophistication but, as a general rule, traditional systems tend to be simplistic whereas ABC systems tend to be more sophisticated. What determines the chosen level of sophistication of a costing system? The answer is that the choice should be made on costs versus benefits criteria. Simplistic systems are inexpensive to operate, but they are likely to result in inaccurate cost assignments and the reporting of inaccurate costs. Managers using cost information extracted from simplistic systems are more likely to make important mistakes arising from using inaccurate cost information. The end result may be a high cost of errors. Conversely, sophisticated systems are more expensive to operate but they minimize the cost of errors. However, the aim should not be to have the most accurate cost system. Improvements should be made in the level of sophistication of the costing system up to the point where the marginal cost of improvement equals the marginal benefit from the improvement.

Figure 4.2 illustrates the above points with costing systems ranging from simplistic to sophisticated. Highly simplistic costing systems are located on the extreme left. Common features of such systems are that they are inexpensive to operate, make extensive use of arbitrary allocations of indirect costs and normally result in low levels

FIGURE 4.2 *Cost systems – varying levels of sophistication for cost assignment*



of accuracy and a high cost of errors. On the extreme right are highly sophisticated systems. These systems use only cause-and-effect allocations, are more expensive to operate, have high levels of accuracy and minimize the cost of errors. Cost systems in most organizations are not located at either of these extreme points. Instead, they are located at different points within the range shown in Figure 4.2.

The optimal cost system is different for different organizations. For example, the optimal costing system will be located towards the extreme left for an organization whose indirect costs are a low percentage of total costs and which also has a fairly standardized product range, all consuming organizational resources in similar proportions. In these circumstances simplistic systems may not result in the reporting of inaccurate costs. In contrast, the optimal costing system for organizations with a high proportion of indirect costs, whose products consume organizational resources in different proportions, will be located towards the extreme right. More sophisticated costing systems are required to capture the diversity of consumption of organizational resources and accurately assign the high level of indirect costs to different cost objects.

Assigning direct costs to cost objects

Both simplistic and sophisticated systems accurately assign direct costs to cost objects. Cost assignment merely involves the implementation of suitable clerical procedures to identify and record the resources consumed by cost objects. Consider direct labour. The time spent on providing a service to a specific customer, or manufacturing a specific product, is recorded on source documents, such as **time sheets** or **job cards**. Details of the customer's account number, job number or the product's code are also entered on these documents. The employee's hourly rate of pay is then entered so that the direct labour cost for the employee can be assigned to the appropriate cost object.

For direct materials the source document is a **materials requisition**. Details of the materials issued for manufacturing a product, or providing a specific service, are recorded on the materials requisition. The customer's account number, job number or product code is also entered and the items listed on the requisition are priced at their cost of acquisition. The details on the material requisition thus represent the source information for assigning the cost of the materials to the appropriate cost object.

In many organizations the recording procedure for direct costs is computerized using barcoding and other forms of on-line information recording. The source documents only exist in the form of computer records. Because direct costs can be accurately

assigned to cost objects whereas many indirect costs cannot, the remainder of this chapter will focus on indirect cost assignment.

Plant-wide (blanket) overhead rates

The most simplistic traditional costing system assigns indirect costs to cost objects using a single overhead rate for the organization as a whole. You will recall at the start of this chapter that it was pointed out that indirect costs are also called overheads. The terms **blanket overhead rate** or **plant-wide rate** are used to describe a single overhead rate that is established for the organization as a whole. Let us assume that the total manufacturing overheads for the manufacturing plant of Arcadia are £900 000 and that the company has selected direct labour hours as the allocation base for assigning overheads to products. Assuming that the total number of direct labour hours are 60 000 for the period the plant-wide overhead rate for Arcadia is £15 per direct labour hour (£900 000/60 000 direct labour hours). This calculation consists of two stages. First, overheads are accumulated in one single plant-wide pool for a period. Second, a plant-wide rate is computed by dividing the total amount of overheads accumulated (£900 000) by the selected allocation base (60 000 direct labour hours). The overhead costs are assigned to products by multiplying the plant-wide rate by the units of the selected allocation base (direct labour hours) used by each product.

Assume now that Arcadia is considering establishing separate overheads for each of its three production departments. Further investigations reveal that the products made by the company require different operations and some products do not pass through all three departments. These investigations also indicate that the £900 000 total manufacturing overheads and 60 000 direct labour hours can be analysed as follows:

	Department A	Department B	Department C	Total
Overheads	£200 000	£600 000	£100 000	£900 000
Direct labour hours	20 000	20 000	20 000	60 000
Overhead rate per direct labour hour	£10	£30	£5	£15

Consider now a situation where product Z requires 20 direct labour hours in department C but does not pass through departments A and B. If a plant-wide overhead rate is used then overheads of £300 (20 hours at £15 per hour) will be allocated to product Z. On the other hand, if a departmental overhead rate is used, only £100 (20 hours at £5 per hour) would be allocated to product Z. Which method should be used? The logical answer must be to establish separate departmental overhead rates, since product Z only consumes overheads in department C. If the plant-wide overhead rate were applied, all the factory overhead rates would be averaged out and product Z would be indirectly allocated with some of the overheads of department B. This would not be satisfactory, since product Z does not consume any of the resources and this department incurs a large amount of the overhead expenditure.

Where some departments are more 'overhead-intensive' than others, products spending more time in the overhead-intensive departments should be assigned more overhead costs than those spending less time. Departmental rates capture these possible effects but plant-wide rates do not, because of the averaging process. We can conclude that a plant-wide rate will generally result in the reporting of inaccurate

product costs. A plant-wide rate can only be justified when all products consume departmental overheads in approximately the same proportions. In the above illustration each department accounts for one-third of the total direct labour hours. If all products spend approximately one-third of their time in each department, a plant-wide overhead rate can be used. Consider a situation where product X spends one hour in each department and product Y spends five hours in each department. Overheads of £45 and £225 respectively would be allocated to products X and Y using either a plant-wide rate (3 hours at £15 and 15 hours at £15) or separate departmental overhead rates. If a diverse product range is produced with products spending different proportions of time in each department, separate departmental overhead rates should be established.

However, significant usage of plant-wide overhead rates have been reported in surveys undertaken in many different countries. For example, the percentage usages vary from 20–30% in UK (Drury and Tayles, 1994), USA (Emore and Ness, 1991), Australian (Joye and Blayney, 1990; 1991) and Indian (Joshi, 1998) surveys. In contrast, in Scandinavia only 5% of the Finnish companies (Lukka and Granlund, 1996), one Norwegian company (Bjornenak, 1997b) and none of the Swedish companies sampled (Ask *et al*., 1996) used a single plant-wide rate. Zero usage of plant-wide rates was also reported from a survey of Greek companies (Ballas and Venieris, 1996). In a more recent study of UK organizations Drury and Tayles (2000) reported that a plant-wide rate was used by 3% of surveyed organizations, possibly suggesting a move towards more sophisticated costing systems.

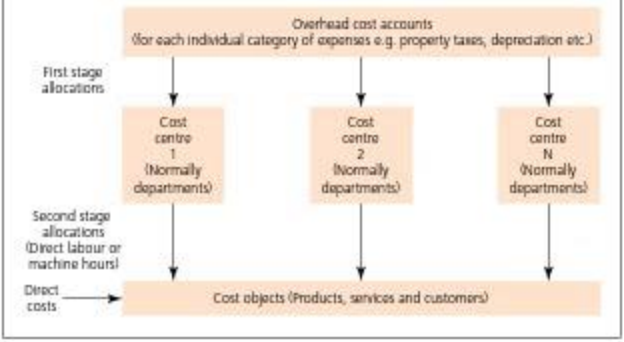
The two-stage allocation process

A framework, known as the two-stage allocation process, can be used to summarize the different approaches we have looked at for Arcadia to assign overhead costs to products. The process applies to assigning costs to other cost objects, besides products, and is applicable to all organizations that assign indirect costs to cost objects. The framework applies to both traditional and ABC systems.

The framework is illustrated in Figure 4.3. You can see that in the first stage overheads are assigned to cost centres (also called cost pools). The terms **cost centres** or **cost pools** are used to describe a location to which overhead costs are initially assigned. Normally cost centres consist of departments, but in some cases they consist of smaller segments such as groups of machines. In the second stage the costs accumulated in the cost centres are allocated to cost objects using selected allocation bases (you should remember from our discussion earlier that allocation bases are also called cost drivers). Traditional costing systems tend to use a small number of second stage allocation bases, typically direct labour hours or machine hours. In other words, traditional systems assume that direct labour or machine hours have a significant influence in the long term on the level of overhead expenditure. Other allocation bases used to a lesser extent by traditional systems are direct labour cost, direct materials cost and units of output. These methods are described and illustrated in Appendix 4.2 at the end of this chapter. Exhibit 4.1 (Section C) shows details of the extent to which different second stage allocation bases are used in different countries. You will see that direct labour and machine hours are the dominant methods.

Let us now apply the framework to our discussion in the previous stage relating to Arcadia. The plant-wide rate overheads (£900 000) are collected in a single cost pool for the plant, or the whole organization if non-manufacturing overheads are to be incorporated in the overhead rate. In the second stage a single plant-wide overhead rate (£15 per hour) is allocated to products based on the number of direct labour hours used by each product.

FIGURE 4.3 *An illustration of the two-stage allocation process for a traditional costing system*



We concluded that, because some departments were more 'overhead intensive' than others, it is preferable to establish separate cost centre overhead rates based on departments. With this approach the total overheads of £900 000 were assigned to the three production departments in the first stage. Separate departmental overhead rates were computed for each department in the second stage (i.e. £10 per direct labour hour department A, £30 for B and £5 for C). Finally, departmental overheads were assigned to products by multiplying the hours spent by a product in each department by the hourly overhead rate. The total overhead assigned to a product is simply the sum of the amounts applied in each department.

How many cost centres should a firm establish? If only a small number of cost centres are established it is likely that activities within a cost centre will not be homogeneous and, if the consumption of the activities by products/services within the cost centres varies, activity resource consumption will not be accurately measured. Therefore, in most situations, increasing the number of cost centres increases the accuracy of measuring the indirect costs consumed by cost objects. The choice of the number of cost centres should be based on cost–benefit criteria using the principles described on pages 90–91. Exhibit 4.1 (Section A) shows the number of cost centres and second stage cost allocation bases reported by Drury *et al.* in a survey of 187 UK organizations. It can be seen that 35% of the organizations used less than 11 cost centres whereas 23% used more than 30 cost centres. In terms of the number of different types of second stage cost drivers/allocation bases 69% of the responding organizations used less than four.

An illustration of the two-stage process for a traditional costing system

We shall now use Example 4.1 to provide a more detailed illustration of the two-stage allocation process for a traditional costing system. To keep the illustration

EXHIBIT 4.1
Surveys of practice

(a) Cost centres used in the first stage of the two-stage allocation process

- A survey of Australian organizations by Joye and Blayney (1990):
  36% of the responding organizations used a single plant-wide rate
  24% used overhead rates for groups of work centres
  31% used overhead rates for each work centre
  9% used overhead rates for each machine
- A survey of Swedish organizations by Ask and Ax (1992)[a]:
  70% indicated that cost centres consisted of departments
  32% consisted of work cells
  22% consisted of groups of machines
  15% consisted of single machines
- A Norwegian study by Bjornenak (1997b) reported an average of 38.3 cost centres used by the respondents
- A survey of UK organizations by Drury and Tayles (2000):
  14% used less than 6 cost centres
  21% used 6–10 cost centres
  29% used 11–20 cost centres
  36% used more than 20 cost centres

(b) Number of different second stage allocation bases/cost drivers used

- A survey of UK organizations by Drury and Tayles (2000):
  34% used 1 cost driver
  25% used 2 drivers
  10% used 3 drivers
  21% used 3–10 drivers
  10% used more than 10 drivers
- A Norwegian study by Bjornenak (1997a) reported an average usage of 1.79 cost drivers

(c) Second stage cost allocation bases/cost drivers used[e]

	Norway[b]	Holland[c]	Ireland[d]	Australia[e]	Japan[e]	UK[f]	UK[f]
Direct labour hours/cost	65%	20%	52%	57%	57%	68%	73%
Machine hours	29	9	19	19	12	49	26
Direct materials costs	26	6	10	12	11	30	19
Units of output	40	30	28	20	16	42	31
Prime cost				1	21		
Other	23	35	9				
ABC cost drivers						9	7

A survey of Finnish companies by Lukka and Granlund (1996) reported that direct labour costs, direct labour hours, machine hours, materials use and production quantity were the most widely used allocation bases. Usage rates were not reported.

Notes
[a] The reported percentages exceed 100% because many companies used more than one type of cost centre or allocation base.
[b] Bjornenak (1997b).
[c] Boons *et al.* (1994).
[d] Clarke (1995).
[e] Blayney and Yokoyama (1991).
[f] Drury *et al.* (1993) – The first column relates to the responses for automated and the second to non-automated production centres.

manageable it is assumed that the company has only five cost centres – machine departments X and Y, an assembly department, and materials handling and general factory support cost centres. The illustration focuses on manufacturing costs but we shall look at non-manufacturing costs later in the chapter. Applying the two-stage allocation process requires the following four steps:

1 assigning all manufacturing overheads to production and service cost centres;
2 reallocating the costs assigned to service cost centres to production cost centres;
3 computing separate overhead rates for each production cost centre;
4 assigning cost centre overheads to products or other chosen cost objects.

Steps 1 and 2 comprise stage one and steps 3 and 4 relate to the second stage of the two-stage allocation process. Let us now consider each of these steps in detail.

Step 1 – Assigning all manufacturing overheads to production and service cost centres

Using the information given in Example 4.1 our initial objective is to assign all manufacturing overheads to production and service cost centres. To do this requires the preparation of an **overhead analysis sheet**. This document is shown in Exhibit 4.2. In many organizations it will exist only in computer form.

If you look at Example 4.1 you will see that the indirect labour and indirect material costs have been directly traced to cost centres. Although these items cannot be directly assigned to products they can be directly assigned to the cost centres. In other words, they are indirect costs when products are the cost objects and direct costs when cost centres are the cost object. Therefore they are traced directly to the cost centres shown in the overhead analysis sheet in Exhibit 4.2. The remaining costs shown in Example 4.1 cannot be traced directly to the cost centres and must be allocated to the cost centre using appropriate allocation bases. The term **first stage allocation bases** is used to describe allocations at this point. The following list summarizes commonly used first stage allocation bases:

Cost	Basis of allocation
Property taxes, lighting and heating	Area
Employee-related expenditure:	
works management, works canteen, payroll office	Number of employees
Depreciation and insurance of plant and machinery	Value of items of plant and machinery

EXAMPLE 4.1

The annual overhead costs for the Enterprise Company which has three production centres (two machine centres and one assembly centre) and two service centres (materials procurement and general factory support) are as follows:

	(£)	(£)
Indirect wages and supervision		
Machine centres: X	1 000 000	
Y	1 000 000	
Assembly	1 500 000	
Materials procurement	1 100 000	
General factory support	1 480 000	6 080 000
Indirect materials		
Machine centres: X	500 000	
Y	805 000	
Assembly	105 000	
Materials procurement	0	
General factory support	10 000	1 420 000
Lighting and heating	500 000	
Property taxes	1 000 000	
Insurance of machinery	150 000	
Depreciation of machinery	1 500 000	
Insurance of buildings	250 000	
Salaries of works management	800 000	4 200 000
		11 700 000

The following information is also available:

	Book value of machinery (£)	Area occupied (sq. metres)	Number of employees	Direct labour hours	Machine hours
Machine shop: X	8 000 000	10 000	300	1 000 000	2 000 000
Y	5 000 000	5 000	200	1 000 000	1 000 000
Assembly	1 000 000	15 000	300	2 000 000	
Stores	500 000	15 000	100		
Maintenance	500 000	5 000	100		
	15 000 000	50 000	1000		

Details of total materials issues (i.e. direct and indirect materials) to the production centres are as follows:

	£
Machine shop X	4 000 000
Machine shop Y	3 000 000
Assembly	1 000 000
	8 000 000

To allocate the overheads listed above to the production and service centres we must prepare an overhead analysis sheet, as shown in Exhibit 4.2.

EXHIBIT 4.2

Overhead analysis sheet

			Production centres			Service centres	
Item of expenditure	Basis of allocation	Total (£)	Machine centre X (£)	Machine centre Y (£)	Assembly (£)	Materials procurement (£)	General factory support (£)
Indirect wage and supervision	Direct	6 080 000	1 000 000	1 000 000	1 500 000	1 100 000	1 480 000
Indirect materials	Direct	1 420 000	500 000	805 000	105 000		10 000
Lighting and heating	Area	500 000	100 000	50 000	150 000	150 000	50 000
Property taxes	Area	1 000 000	200 000	100 000	300 000	300 000	100 000
Insurance of machinery	Book value of machinery	150 000	80 000	50 000	10 000	5 000	5 000
Depreciation of machinery	Book value of machinery	1 500 000	800 000	500 000	100 000	50 000	50 000
Insurance of buildings	Area	250 000	50 000	25 000	75 000	75 000	25 000
Salaries of works management	Number of employees	800 000	240 000	160 000	240 000	80 000	80 000
	(1)	11 700 000	2 970 000	2 690 000	2 480 000	1 760 000	1 800 000
Reallocation of service centre costs							
Materials procurement	Value of materials issued	—	880 000	660 000	220 000	1 760 000	
General factory support	Direct labour hours	—	450 000	450 000	900 000		1 800 000
	(2)	11 700 000	4 300 000	3 800 000	3 600 000	—	—
Machine hours and direct labour hours		2 000 000	1 000 000	2 000 000			
Machine hour overhead rate			£2.15	£3.80			
Direct labour hour overhead rate					£1.80		

Applying the allocation bases to the data given in respect of the Enterprise Company in Example 4.1 it is assumed that property taxes, lighting and heating, and insurance of buildings are related to the total floor area of the buildings, and the benefit obtained by each cost centre can therefore be ascertained according to the



Views on the treatment of manufacturing overheads

A questionnaire survey by Brealey (2006) reported the following results in respect of UK manufacturing companies:

	N	%
Blanket (plant-wide rates)	31	13
Production department rates	150	63
Activity-based costing rates	8	4
Variable costing rates (i.e. overheads not assigned to products)	45	19
Other	3	1
	237	100

Nine of the 31 respondents who used a blanket rate were interviewed to ascertain the reasons for using such a rate. Five interviewees were happy with the product costs derived from using this rate and four acknowledged its limitations. The following is a response from one of the respondents that argued that the improved accuracy of the product costs derived from a blanket overhead rate could not be justified on cost–benefit criteria:

> *The added value … for breaking [*the overhead*] down any further would be minimal. … I think if I go down any further within separate areas in the manufacturing operations to split down production, purchasing and quality departments, I don't think it would make much difference to the blanket overhead rate that we've got.*

One of the four interviewees who acknowledged the limitations of blanket overhead rates argued that it was reasonable to use a blanket rate because overheads were a small proportion of total costs. The second interviewee argued that the rate was used because it was simple to calculate and the third cited a lack of resources. The final interviewee intended to change from a blanket rate to multiple departmental rates.

Forty of the respondents who used separate production department rates were interviewed. Reasons cited for using these rates included: the factory was divided into different production processes; cost centres use different resources in different proportions: and the fact that the factory was organized so that each production department was responsible for a product group. One respondent justified the use of separate overhead rates throughout the factory as follows:

> *We actually have manufacturing cells which are cost centres in their own right, so it's best if we have a cost centre which is trying to recover those costs against what it's manufacturing. So rather than saying we have lots of manufacturing cells but only one cost centre, it seems more straightforward to say here's a cell of cost which manufactures and fills something and does some sort of service. It's easier to allocate the costs so that a particular cost centre can recover the costs of that cost centre and certainly you can see overall whether it's over or under recovering.*

Five interviews were conducted with units that only assigned variable costs to products. They justified this approach on the grounds that fixed overheads would remain unchanged irrespective of the decisions that were made so they were irrelevant for decision-making.

Source: Brealey, J. A. (2006), The calculation of product costs and their use in decision-making in the British Manufacturing Industry, PhD dissertation, University of Huddersfield

proportion of floor area which it occupies. The total floor area of the factory shown in Example 4.1 is 50 000 square metres; machine centre X occupies 20% of this and machine centre Y a further 10%. Therefore, if you refer to the overhead analysis sheet in Exhibit 4.2 you will see that 20% of property taxes, lighting and heating and insurance of buildings are allocated to machine centre X, and 10% are allocated to machine centre Y.

The insurance premium paid and depreciation of machinery are generally regarded as being related to the book value of the machinery. Because the book value of machinery for machine centre X is 8/15 of the total book value and machine centre Y is 5/15 of the total book value then 8/15 and 5/15 of the insurance and depreciation of machinery is allocated to machine centres X and Y.

It is assumed that the amount of time that works management devotes to each cost centre is related to the number of employees in each centre; since 30% of the total employees are employed in machine centre X, 30% of the salaries of works management will be allocated to this centre.

If you now look at the overhead analysis sheet shown in Exhibit 4.2, you will see in the row labelled '(1)' that all manufacturing overheads for the Enterprise Company have been assigned to the three production and two service cost centres.

Step 2 – Reallocating the costs assigned to service cost centres to production cost centres

The next step is to reallocate the costs that have been assigned to service cost centres to production cost centres. **Service departments** (i.e. service cost centres) are those departments that exist to provide services of various kinds to other units within the organization. They are sometimes called **support departments**. The Enterprise Company has two service centres. They are materials procurement and general factory support which includes activities such as production scheduling and machine maintenance. These service centres render essential services that support the production process, but they do not deal directly with the products. Therefore it is not possible to allocate service centre costs to products passing through these centres. To assign costs to products traditional costing systems reallocate service centre costs to production centres that actually work on the product. The method that is chosen to allocate service centre costs to production centre should be related to the benefits that the production centres derive from the service rendered.

We shall assume that the value of materials issued (shown in Example 4.1) provides a suitable approximation of the benefit that each of the production centres receives from materials procurement. Therefore 50% of the value of materials is issued to machine centre X, resulting in 50% of the total costs of materials procurement being allocated to this centre. If you refer to Exhibit 4.2 you will see that £880 000 (50% of material procurement costs of £1 760 000) has been reallocated to machine centre X. It is also assumed that direct labour hours provides an approximation of the benefits received by the production centres from general factory support resulting in the total costs for this centre being reallocated to the production centres proportionate to direct labour hours. Therefore since machine centre X consumes 25% of the direct labour hours £450 000 (25% of the total costs of £1 800 000 assigned to general factory support) has been reallocated to machine centre X. You will see in the row labelled '(2)' in Exhibit 4.2 that all manufacturing costs have now been assigned to the three production centres. This completes the first stage of the two-stage allocation process.

Step 3 – Computing separate overhead rates for each production cost centre

The second stage of the two-stage process is to allocate overheads of each production centre to overheads passing through that centre. The most frequently used allocation bases in traditional costing systems are based on the amount of time products spend in each production centre – normally direct labour hours and machine hours. In respect of non-machine centres, direct labour hours is the most frequently used allocation base. This implies that the overheads incurred by a production centre are closely related to direct labour hours worked. In the case of machine centres a machine hour overhead rate is preferable since most of the overheads (e.g. depreciation) are likely to be more closely related to machine hours. We shall assume that the Enterprise Company uses a **machine hour rate** for the machine production centres and a **direct labour hour rate** for the assembly centre. The overhead rates are calculated by applying the following formula:

$$\frac{\text{cost centre overheads}}{\text{cost centre direct labour hours or machine hours}}$$

The calculations using the information given in Example 4.1 are as follows:

$$\text{Machine centre X} = \frac{£4\,300\,000}{2\,000\,000 \text{ machine hours}} = £2.15 \text{ per machine hour}$$

$$\text{Machine centre Y} = \frac{£3\,800\,000}{1\,000\,000 \text{ machine hours}} = £3.80 \text{ per machine hour}$$

$$\text{Assembly department} = \frac{£3\,600\,000}{2\,000\,000 \text{ direct labour hours}} = £1.80 \text{ per direct labour hour}$$

Step 4 – Assigning cost centre overheads to products or other chosen cost objects

The final step is to allocate the overheads to products passing through the production centres. Therefore if a product spends 10 hours in machine cost centre A overheads of £21.50 (10 × £2.15) will be allocated to the product. We shall compute the manufacturing costs of two products. Product A is a low sales volume product with direct costs of £100. It is manufactured in batches of 100 units and each unit requires 5 hours in machine centre A, 10 hours in machine centre B and 10 hours in the assembly centre. Product B is a high sales volume product thus enabling it to be manufactured in larger batches. It is manufactured in batches of 200 units and each unit requires 10 hours in machine centre A, 20 hours in machine centre B and 20 hours in the assembly centre. Direct costs of £200 have been assigned to product B. The calculations of the manufacturing costs assigned to the products are as follows:

Product A	£
Direct costs (100 units × £100)	10 000
Overhead allocations	
Machine centre A (100 units × 5 machine hours × £2.15)	1 075
Machine centre B (100 units × 10 machine hours × £3.80)	3 800
Assembly (100 units × 10 direct labour hours × £1.80)	1 800
Total cost	16 675
Cost per unit (£16 675/100 units) = £166.75	

Product B	£
Direct costs (200 units × £200)	40 000
Overhead allocations	
Machine centre A (200 units × 10 machine hours × £2.15)	4 300
Machine centre B (200 units × 20 machine hours × £3.80)	15 200
Assembly (200 units × 20 direct labour hours × £1.80)	7 200
Total cost	66 700
Cost per unit (£66 700/200 units) = £333.50	

The overhead allocation procedure is more complicated where service cost centres serve each other. In Example 4.1 it was assumed that materials procurement does not provide any services for general factory support and that general factory support does not provide any services for materials procurement. An understanding of situations where service cost centres do serve each other is not, however, necessary for a general understanding of the overhead procedure, and the problem of service centre reciprocal cost allocations is therefore dealt with in Appendix 4.1.

Extracting relevant costs for decision-making

The cost computations relating to the Enterprise Company for products A and B represent the costs that should be generated for meeting stock valuation and profit measurement requirements. For decision-making non-manufacturing costs should also be taken into account. In addition, some of the costs that have been assigned to the products may not be relevant for certain decisions. For example, if you look at the overhead analysis sheet in Exhibit 4.2 you will see that property taxes, depreciation of machinery and insurance of buildings and machinery have been assigned to cost centres, and thus included in the costs assigned to products. If these cost are unaffected by a decision to discontinue a product they should not be assigned to products when undertaking product discontinuation reviews. However, if cost information is used to determine selling prices such costs may need to be assigned to products to ensure that the selling price of a customer's order covers a fair share of all organizational costs. It is therefore necessary to ensure that the costs incorporated in the overhead analysis are suitably coded so that different overhead rates can be extracted for different combinations of costs. This will enable relevant cost information to be extracted from the database for meeting different requirements. For an illustration of this approach you should refer to the answer to Review problem 4.26 shown at the end of this chapter.

Our objective in this chapter has not been to focus on the cost information that should be extracted from the costing system for meeting decision-making requirements. Instead, it is to provide you with an understanding of how cost systems assign costs to cost objects. In Chapter 10 we shall concentrate on the cost information that should be extracted for decision-making.

Budgeted overhead rates

Our discussion in this chapter has assumed that the *actual* overheads for an accounting period have been allocated to the products. However, the calculation of overhead rates based on the *actual* overheads incurred during an accounting period causes a number of problems. First, the product cost calculations have to be delayed until the end of the accounting period, since the overhead rate calculations cannot be obtained before this date, but information on product costs is required quickly if it is to be used for monthly profit calculations and inventory valuations or as a basis for setting selling prices. Secondly, one may argue that the timing problem can be resolved by calculating actual overhead rates at more frequent intervals, say on a monthly basis, but the objection to this proposal is that a large amount of overhead expenditure is fixed in the short term whereas activity will vary from month to month, giving large fluctuations in the overhead rates. Consider Example 4.2.

Such fluctuating overhead rates are not representative of typical, normal production conditions. Management has committed itself to a specific level of fixed costs in the light of foreseeable needs for beyond one month. Thus, where production fluctuates, monthly overhead rates may be volatile. Furthermore, some costs such as repairs, maintenance and heating are not incurred evenly throughout the year. Therefore, if monthly overhead rates are used, these costs will not be allocated fairly to units of output. For example, heating costs would be charged only to winter production so that products produced in winter would be more expensive than those produced in summer.

An average, annualized rate based on the relationship of total annual overhead to total annual activity is more representative of typical relationships between total costs and volume than a monthly rate. What is required is a normal product cost based on average long-term production rather than an actual product cost, which is affected by month-to-month fluctuations in production volume. Taking these factors into consideration, it is preferable to establish a **budgeted overhead rate** based on annual *estimated* overhead expenditure and activity. Consequently the procedure outlined in the previous sections for calculating cost centre overhead rates for traditional and ABC systems should be based on *standard* activity levels and not *actual* activity levels. Surveys of product costing practices indicate that most organizations use annual budgeted activity as a measure of standard activity.

Under- and over-recovery of overheads

The effect of calculating overhead rates based on budgeted annual overhead expenditure and activity is that it will be most unlikely that the overhead allocated to products manufactured during the period will be the same as the actual overhead incurred. Consider a situation where the estimated annual fixed overheads are £2 000 000 and the estimated annual activity is 1 000 000 direct labour hours. The estimated fixed

EXAMPLE 4.2

The fixed overheads for Euro are £24 000 000 per annum, and monthly production varies from 400 000 to 1 000 000 hours. The monthly overhead rate for fixed overhead will therefore fluctuate as follows:

Monthly overhead	£2 000 000	£2 000 000
Monthly production	400 000 hours	1 000 000 hours
Monthly overhead rate	£5 per hour	£2 per hour

Overhead expenditure that is fixed in the short term remains constant each month, but monthly production fluctuates because of holiday periods and seasonal variations in demand. Consequently the overhead rate varies from £2 to £5 per hour. It would be unreasonable for a product worked on in one month to be allocated overheads at a rate of £5 per hour and an identical product worked on in another month allocated at a rate of only £2 per hour.

overhead rate will be £2 per hour. Assume that actual overheads are £2 000 000 and are therefore identical with the estimate, but that actual activity is 900 000 direct labour hours instead of the estimated 1 000 000 hours. In this situation only £1 800 000 will be charged to production. This calculation is based on 900 000 direct labour hours at £2 per hour, giving an under-recovery of overheads of £200 000.

Consider an alternative situation where the actual overheads are £1 950 000 instead of the estimated £2 000 000, and actual activity is 1 000 000 direct labour hours, which is identical to the original estimate. In this situation 1 000 000 direct labour hours at £2 per hour will be charged to production giving an over-recovery of £50 000. This example illustrates that there will be an **under- or over-recovery of overheads** whenever actual activity or overhead expenditure is different from the budgeted overheads and activity used to estimate the budgeted overhead rate. This under- or over-recovery of fixed overheads is also called a **volume variance**.

Accounting regulations in most countries recommend that the under- or over-recovery of overheads should be regarded as a period cost adjustment. For example, the UK Statement of Standard Accounting Practice on Stocks and Work in Progress (SSAP 9) and the International Accounting Standard on Inventories (IAS2) recommend that the allocation of overheads in the valuation of inventories and work in progress needs to be based on the company's normal level of activity and that any under- or over-recovery should be written off in the current year. This procedure is illustrated in Figure 4.4. Note that any under- or over-recovery of overhead is not allocated to products. Also note that the under-recovery is recorded as an expense in the current accounting period whereas an over-recovery is recorded as a reduction in the expenses for the period. Finally you should note that our discussion here is concerned with how to treat any under- or over-recovery for the purpose of financial accounting and its impact on inventory valuation and profit measurement.

Maintaining the database at standard costs

Most organizations whose activities consist of a series of common or repetitive operations maintain their database at standard, rather than actual cost, for both traditional

FIGURE 4.4 *Illustration of under-recovery of factory overheads*



and ABC systems. **Standard costs** are predetermined target costs that should be incurred under efficient operating conditions. For example, assume that the standard direct labour cost for performing a particular operation is £40 (consisting of 5 hours at £8 per hour) and the standard cost of a purchased component (say component Z) is £50. The direct costs for a product requiring only this operation and the purchased component Z would be recorded in the database at a standard cost of £90. Assuming that the product only passed through a single cost centre with a budgeted overhead rate of £20 per direct labour hour the overhead cost for the product would be recorded in the database at £100 standard cost (5 standard direct labour hours at £20 per hour). Instead of a product being recorded in the database at its standard *unit* cost the database may consist of the standard costs of a batch of output, such as normal batch sizes of say 100 or 200 units output of the product.

When a standard costing system is used the database is maintained at standard cost and actual output is costed at the standard cost. Actual costs are recorded, but not at the individual product level, and an adjustment is made at the end of the accounting period by recording as a period cost the difference between standard cost and actual cost for the actual output. This adjustment ensures that the standard costs are converted to actual costs in the profit statement for meeting external financial accounting reporting requirements.

It is not important at this point that you have a detailed understanding of a standard costing system. However, it is important that you are aware that a database may consist of standard (estimated) costs rather than actual costs. We shall look at standard costing in detail in Chapter 18.

Non-manufacturing overheads

In respect of financial accounting, only manufacturing costs are allocated to products. Non-manufacturing overheads are regarded as period costs and are disposed of in exactly the same way as the under- or over-recovery of manufacturing overheads outlined in Figure 4.4. For external reporting it is therefore unnecessary to allocate non-manufacturing overheads to products. However, for decision-making non-manufacturing costs should be assigned to products. For example, in many organizations it is not uncommon for selling prices to be based on estimates of total cost or even actual cost. Housing contractors and garages often charge for their services by adding a percentage profit margin to actual cost.

EXHIBIT 4.3

Methods used by UK organizations to allocate non-manufacturing overheads to products

	(%)
Allocation as a percentage of total manufacturing cost	32
Direct labour hours/cost methods	25
Percentage of total selling price	12
Non-manufacturing overheads not traced to products	23
Other method	8
	100

Source: Drury *et al.* (1993).

EXAMPLE 4.3

The estimated non-manufacturing overhead and manufacturing costs of a company for the year ending 31 December are £500 000 and £1 million respectively. The non-manufacturing overhead absorption rate is calculated as follows:

$$\frac{\text{estimated non-manufacturing overhead}}{\text{estimated manufacturing cost}}$$

In percentage terms each product will be allocated with non-manufacturing overheads at a rate of 50% of its total manufacturing cost.

Some non-manufacturing costs may be a direct cost of the product. Delivery costs, salesmen's salaries and travelling expenses may be directly identifiable with the product, but it is likely that many non-manufacturing overheads cannot be allocated directly to specific products. On what basis should we allocate non-manufacturing overheads? The answer is that we should select an allocation base/cost driver that corresponds most closely to non-manufacturing overheads. The problem is that allocation bases that are widely used by traditional costing systems, such as direct labour hours, machine hours and direct labour cost are not necessarily those that are closely related to non-manufacturing overheads. Therefore traditional systems tend to use arbitrary, rather than cause-and-effect allocation bases, to allocate non-manufacturing overheads to products. The most widely used approach (see Exhibit 4.3) is to allocate non-manufacturing overheads on the ability of the products to bear such costs. This approach can be implemented by allocating non-manufacturing costs to products on the basis of their manufacturing costs. This procedure is illustrated in Example 4.3.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Distinguish between cause-and-effect and arbitrary allocations.**

  Direct costs can be directly traced to cost objects whereas indirect costs cannot. Therefore, indirect costs must be assigned using cost allocation bases. Allocation bases which are significant determinants of costs that are being allocated are described as cause-and-effect allocations whereas arbitrary allocations refer to allocation bases that are not the significant determinants of the costs. To accurately measure the cost of resources used by cost objects cause-and-effect allocations should be used.

- **Explain why different cost information is required for different purposes.**

  Manufacturing organizations assign costs to products for two purposes: first for external (financial accounting) profit measurement and inventory valuation purposes in order to allocate manufacturing costs incurred during a period to cost of goods sold and inventories; secondly to provide useful information for managerial decision-making requirements. Financial accounting regulations specify that only manufacturing costs should be assigned to products for meeting inventory and profit measurement requirements. Both manufacturing and non-manufacturing costs, however, may be relevant for decision-making. In addition, not all costs that are assigned to products for inventory valuation and profit measurement are relevant for decision-making. For example, costs that will not be affected by a decision (e.g. depreciation) are normally not relevant for decision-making.

- **Describe how cost systems differ in terms of their level of sophistication.**

  Cost systems range from simplistic to sophisticated. Simplistic systems are inexpensive to operate, involve extensive use of arbitrary allocations, have a high likelihood of reporting inaccurate product costs and generally result in a high cost of errors. Sophisticated costing systems are more expensive to operate, rely more extensively on cause-and-effect allocations, generally report more accurate product costs and have a low cost of errors. Further distinguishing features are that simplistic costing systems have a small number of first-stage cost centres/pools and use a single second-stage cost driver. In contrast, sophisticated costing systems use many first-stage cost centres/pools and many different types of second-stage drivers.

- **Understand the factors influencing the choice of an optimal costing system.**

  The optimal costing system is different for different organizations and should be determined on a costs versus benefits basis. Simplistic costing systems are appropriate in organizations whose indirect costs are a low percentage of total costs and which also have a fairly standardized product range, all consuming organizational resources in similar proportions. Under these circumstances simplistic costing systems may report costs that are sufficiently accurate for decision-making purposes. Conversely, organizations with a high proportion of indirect costs, whose products consume organizational resources in different proportions are likely to require sophisticated costing systems. Relying on sophisticated costing systems under these circumstances is likely to result in the additional benefits from reporting more accurate costs exceeding the costs of operating more sophisticated systems.

- **Explain why departmental overhead rates should be used in preference to a single blanket overhead rate.**

  A blanket (also known as plant-wide) overhead rate establishes a single overhead rate for the organization as a whole whereas departmental rates involve indirect costs being accumulated by different departments and a separate overhead rate being established for each department. A blanket overhead rate can only be justified when all products or services consume departmental overheads in approximately the same proportions. Such circumstances are unlikely to be applicable to most organizations resulting in blanket overheads generally reporting inaccurate product/service costs.

- **Construct an overhead analysis sheet and calculate cost centre allocation rates.**

  Cost centre overhead allocation rates are established and assigned to cost objects using the two-stage allocation overhead procedure. In the first stage, an overhead analysis sheet is used to (a) allocate overheads to production and service centres or departments and (b) to reallocate the total service department overheads to production departments. The second stage involves (a) the calculation of appropriate departmental overhead rates and (b) the allocation of overheads to products passing through each department. These steps were illustrated using data presented in Example 4.1.

- **Justify why budgeted overhead rates should be used in preference to actual overhead rates.**

  Because the uses of actual overhead rates causes a delay in the calculation of product or service costs, and the use of monthly rates causes fluctuations in the overhead rates throughout the year, it is recommended that annual budgeted overhead rates should be used.

- **Calculate and explain the treatment of the under- over-recovery of overheads.**

  The use of annual budgeted overhead rates gives an under- or over-recovery of overheads whenever actual overhead expenditure or activity is different from budget. Any under- or over-recovery is generally regarded as a period cost adjustment and written off to the profit and loss statement and thus not allocated to products.

- **Additional learning objectives presented in Appendices 4.1 and 4.2.**

  The appendices to this chapter include the following two additional learning objectives: (1) to be able to reallocate service department costs to production departments when service departments provide services for other service departments as well as production departments, and (2) to compute overhead allocation rates for other less widely used second-stage methods in traditional costing systems. These topics tend to be included in the syllabus requirements of the examinations set by professional accountancy bodies but may not be part of the course curriculum for other courses. You can omit Appendices 4.1 and 4.2 if these topics are not part of your course curriculum.

Appendix 4.1: Inter-service department reallocation

Service departments provide services for other service departments as well as for production departments. For example, a personnel department provides services for other service departments such as the power generating plant, maintenance department and stores. The power generating department also provides heat and light

for other service departments, including the personnel department, and so on. When such interactions occur, the allocation process can become complicated. Difficulties arise because each service department begins to accumulate charges from other service departments from which it receives services, and these must be reallocated back to the user department. Once it has begun, this allocation and reallocation process can continue for a long time before a solution is found. The problem is illustrated in Example 4A.1. We shall use the example to illustrate four different methods of allocating the service department costs:

1. **repeated distribution method**;
2. **simultaneous equation method**;
3. **specified order of closing method**;
4. **direct allocation method**.

1. Repeated distribution method

Where this method is adopted, the service department costs are repeatedly allocated in the specified percentages until the figures become too small to be significant. You can see from line 2 of Exhibit 4A.1 that the overheads of service department 1 are allocated according to the prescribed percentages. As a result, some of the overheads of service department 1 are transferred to service department 2. In line 3 the overheads of service department 2 are allocated, which means that service department 1 receives some further costs. The costs of service department 1 are again allocated, and service department 2 receives some further costs. This process continues until line 7, by which time the costs have become so small that any further detailed apportionments are unnecessary. As a result, the total overheads in line 8 of £152 040 are allocated to production departments only.

2. Simultaneous equation method

When this method is used simultaneous equations are initially established as follows: Let

$$x = \text{total overhead of service department 1}$$
$$y = \text{total overhead of service department 2}$$

The total overhead transferred into service departments 1 and 2 can be expressed as

$$x = 14\,040 + 0.2y$$
$$y = 18\,000 + 0.1x$$

Rearranging the above equations:

$$x - 0.2y = 14\,040 \quad (1)$$
$$-0.1x + y = 18\,000 \quad (2)$$

We can now multiply equation (1) by 5 and equation (2) by 1, giving

$$5x - y = 70\,200$$
$$-0.1x + y = 18\,000$$

EXAMPLE 4A.1

A company has three production departments and two service departments. The overhead analysis sheet provides the following totals of the overheads analysed to production and service departments:

		(£)
Production department	X	48 000
	Y	42 000
	Z	30 000
Service department	1	14 040
	2	18 000
		152 040

The expenses of the service departments are apportioned as follows:

	Production departments			Service departments	
	X	Y	Z	1	2
Service department 1	20%	40%	30%	—	10%
Service department 2	40%	20%	20%	20%	—

EXHIBIT 4A.1

Repeated distribution method

	Production departments			Service departments		
Line	X	Y	Z	1	2	Total
1 Allocation as per overhead analysis	48 000	42 000	30 000	14 040	18 000	152 040
2 Allocation of service department 1	2 808 (20%)	5 616 (40%)	4 212 (30%)	(14 040)	1 404 (10%)	
					19 404	
3 Allocation of service department 2	7 762 (40%)	3 881 (20%)	3 880 (20%)	3 881 (20%)	(19 404)	
4 Allocation of service department 1	776 (20%)	1 552 (40%)	1 165 (30%)	(3 881)	388 (10%)	
5 Allocation of service department 2	154 (40%)	78 (20%)	78 (20%)	78 (20%)	(388)	
6 Allocation of service department 1	16 (20%)	31 (40%)	23 (30%)	(78)	8 (10%)	
7 Allocation of service department 2	4 (40%)	2 (20%)	2 (20%)	—	(8)	
8 Total overheads	59 520	53 160	39 360	—	—	152 040

Adding the above equations together we have

$$4.9x = 88\,200$$

Therefore $x = 18\,000\ (= 88\,200/4.9)$

Substituting this value for x in equation (1), we have

$$18\,000 - 0.2y = 14\,040$$

Therefore $-0.2y = -3\,960$

Therefore $y = 19\,800$

We now apportion the values for x and y to the production departments in the agreed percentages.

Line	X	Y	Z	Total
1 Allocation as per overhead analysis	48 000	42 000	30 000	120 000
2 Allocation of service department 1	3 600 (20%)	7 200 (40%)	5 400 (30%)	16 200
3 Allocation of service department 2	7 920 (40%)	3 960 (20%)	3 960 (20%)	15 840
4	59 520	53 160	39 360	152 040

You will see from line 2 that the value for X (service department 1) of £18 000 is allocated in the specified percentages. Similarly, in line 3 the value for Y (service department 2) of £19 800 is apportioned in the specified percentages. As a result the totals in line 4 are in agreement with the totals in line 8 of the repeated distribution method (Exhibit 4A.1).

3. Specified order of closing

If this method is used the service departments' overheads are allocated to the production departments in a certain order. The service department that does the largest proportion of work for other service departments is closed first; the service department that does the second largest proportion of work for other service departments is closed second; and so on. Return charges are not made to service departments whose costs have previously been allocated. Let us now apply this method to the information contained in Example 4A.1. The results are given in Exhibit 4A.2.

The costs of service department 2 are allocated first (line 2) because 20% of its work is related to service department 1, whereas only 10% of the work of service department 1 is related to service department 2. In line 3 we allocate the costs of service department 1, but the return charges are not made to department 2. This means that the proportions allocated have changed as 10% of the costs of service department 1 have not been allocated to service department 2. Therefore 20% out of a 90% total or 2/9 of the costs of service department 1 are allocated to department X.

You will see that the totals allocated in line 4 do not agree with the totals allocated under the repeated distribution or simultaneous equation methods. This is because the specified order of closing method sacrifices accuracy for clerical convenience. However, if this method provides a close approximation to an alternative accurate calculation then there are strong arguments for its use.

EXHIBIT 4A.2

Specified order of closing method

	Production departments			Service departments		
Line	X	Y	Z	1	2	Total
1 Allocation as per overhead analysis	48 000	42 000	30 000	14 040	18 000	152 040
2 Allocate service department 2	7 200 (40%)	3 600 (20%)	3 600 (20%)	3 600 (20%)	(18 000)	
3 Allocate service department 1	3 920 (2/9)	7 840 (4/9)	5 880 (3/9)	(17 640)	—	
4	59 120	53 440	39 480	—	—	152 040

EXHIBIT 4A.3

Direct allocation method

	Production departments			Service departments		
Line	X	Y	Z	1	2	Total
1 Allocation as per overhead analysis	48 000	42 000	30 000	14 040	18 000	152 040
2 Allocate service department 1	3 120 (2/9)	6 240 (4/9)	4 680 (3/9)	(14 040)		
3 Allocate service department 2	9 000 (4/8)	4 500 (2/8)	4 500 (2/8)	—	(18 000)	
4	60 120	52 740	39 180	—	—	152 040

4. Direct allocation method

This method is illustrated in Exhibit 4A.3. It ignores inter-service department service reallocations. Therefore service department costs are reallocated only to production departments. This means that the proportions allocated have changed as 10% of the costs of service department 1 have not been allocated to service department 2. Therefore 20% out of a 90% total, or 2/9 of the costs of service department 1, are allo-

cated to department X, 4/9 are allocated to department Y and 3/9 are allocated to department Z. Similarly the proportions allocated for service department 2 have changed with 4/8 (40% out of 80%) of the costs of service department 2 being allocated to department X, 2/8 to department Y and 2/8 to department Z. The only justification for using the direct allocation method is its simplicity. The method is recommended when inter-service reallocations are relatively insignificant.

Appendix 4.2: Other allocation bases used by traditional systems

In the main body of this chapter it was pointed out that traditional costing systems tend to rely on using two second stage allocation bases – namely, direct labour hours and machine hours. Example 4.1 was used to illustrate the application of these allocation bases. With traditional systems it is generally assumed that overhead expenditure is related to output measured by either direct labour hours or machine hours required for a given volume. Products with a high direct labour or machine hour content are therefore assumed to consume a greater proportion of overheads. In addition, to direct labour and machine hours, the following allocation bases are also sometimes used by traditional costing systems:

1. **direct wages percentage method**;
2. **units of output method**;
3. **direct materials percentage method**;
4. **prime cost percentage method**.

Each of these methods is illustrated using the information given in Example 4A.2.

1. Direct wages percentage method

The direct wages percentage overhead rate is calculated as follows:

$$\frac{\text{estimated departmental overheads} \times 100}{\text{estimated direct wages}}$$

Using information given in Example 4A.2,

$$\frac{£200\,000}{£250\,000} \times 100 = 80\% \text{ of direct wages}$$

If we assume that the direct wages cost for a product is £20 then overheads of £16 (80% × £20) will be allocated to the product.

The direct wages percentage method is suitable only where uniform wage rates apply within a cost centre or department. In such a situation this method will yield exactly the same results as the direct labour hour method. However, consider a situation where wage rates are not uniform. Products X and Y spend 20 hours in the same production department, but product X requires skilled labour and product Y requires unskilled labour, with direct wages costs respectively of £200 and £100. If we apply the direct wages percentage overhead rate of 80% we should allocate overheads of £160 to product X and

EXAMPLE 4A.2

The budgeted overheads for a department for the next accounting period are £200 000. In addition, the following information is available for the period:

Estimated direct wages	£250 000
Estimated direct materials	£100 000
Estimated output	10 000 units

£80 to product Y. If both products spend the same amount of time in the department, are such apportioned amounts fair? The answer would appear to be negative, and the direct wages percentage method should therefore only be recommended when similar wage rates are paid to direct employees in a production department.

2. Units of output method

If this method is used, the overhead rate is calculated as follows:

$$\frac{\text{estimated departmental overhead}}{\text{estimated output}}$$

Using the information given in Example 4A.2, this would give an overhead rate of £20 per unit produced. The units of output method is only suitable where all units produced within a department are identical. In other works, it is best suited to a process costing system, and it is not recommended for a job costing system where all jobs or products spend a different amount of time in each production department. If, for example, two of the units produced in Example 4A.2 required 100 hours and 2 hours respectively then they would both be allocated £20. Such an allocation would not be logical.

3. Direct materials percentage method

The direct materials percentage overhead rate is calculated as follows:

$$\frac{\text{estimated departmental overhead}}{\text{estimated direct materials}}$$

Using the information given in Example 4A.2,

$$\frac{£200\,000}{£100\,000} = 200\% \text{ of direct materials}$$

If we assume that the direct material cost incurred by a product in the department is £50 then the product will be allocated with £100 for a share of the overheads of the department.

If the direct materials percentage overhead rate is used, the overheads allocated to products will bear little relationship to the amount of time that products spend in each department. Consequently, this method of recovery cannot normally be recom-

mended, unless the majority of overheads incurred in a department are related to materials rather than time. In particular, the method is appropriate for allocating materials handling expenses to products. With this approach, a cost centre is created for material handling expenses and the expenses are allocated to products using a materials handling overhead rate (normally the direct materials percentage allocation method). Companies that use a materials handling overhead rate allocate the remaining factory overheads to products using one or more of the allocation bases described in this chapter.

4. Prime cost percentage method

The prime cost percentage overhead rate is calculated as follows:

$$\frac{\text{estimated departmental overheads}}{\text{estimated prime cost}} \times 100$$

Using the information given in Example 4A.2, you will see that the estimated prime cost is £350 000, which consists of direct wages of £250 000 plus direct materials of £100 000. The calculation of the overhead rate is

$$\frac{£200\,000}{£350\,000} \times 100 = 57.14\%$$

A product that incurs £100 prime cost in the department will be allocated £57.14 for the departmental overheads.

As prime cost consists of direct wages and direct materials, the disadvantages that apply to the direct materials and direct wages percentage methods also apply to the prime cost percentage method of overhead recovery. Consequently, the prime cost method is not recommended.



Key terms and concepts

activity-based-costing (ABC) (p. 88)
allocation base (p. 88)
arbitrary allocation (p. 88)
blanket overhead rate (p. 92)
budgeted overhead rate (p. 103)
cause-and-effect allocations (p. 88)
cost allocation (p. 88)
cost centre (p. 93)
cost driver (p. 88)
cost pool (p. 93)
cost tracing (p. 88)
direct allocation method (p. 109)
direct labour hour rate (p. 101)
direct materials percentage method (p. 113)
direct wages percentage method (p. 113)
first stage allocation bases (p. 96)
job cards (p. 91)
machine hour rate (p. 101)
materials requisition (p. 91)
overhead analysis sheet (p. 96)
overheads (p. 88)
plant-wide rate (p. 92)
prime cost percentage method (p. 113)
repeated distribution method (p. 109)
service departments (p. 100)
simultaneous equation method (p. 109)
specified order of closing method (p. 109)
standard costs (p. 105)
support departments (p. 100)
time sheets (p. 91)
traditional costing systems (p. 88)
under- or over-recovery of overheads (p. 104)
units of output method (p. 113)
volume variance (p. 104)

Key examination points

A typical question (e.g. Review problem 4.23) will require you to analyse overheads by departments and calculate appropriate overhead allocation rates. These questions may require a large number of calculations, and it is possible that you will make calculation errors. Do make sure that your answer is clearly presented, since marks tend to be allocated according to whether you have adopted the correct method. You are recommended to present your answer in a format similar to Exhibit 4.2. For a traditional costing system you should normally recommend a direct labour hour rate if a department is non-mechanized and a machine hour rate if machine hours are the dominant activity. You should only recommend the direct wages percentage method when the rates within a non-mechanized department are uniform.

Where a question requires you to present information for decision-making, do not include apportioned fixed overheads in the calculations. Remember the total manufacturing costs should be calculated for stock valuation, but incremental costs should be calculated for decision-making purposes (see answer to Review problem 4.26).

Finally, ensure that you can calculate under- or over-recoveries of overheads. To check your understanding of this topic you should refer to the solution to Review problem 4.25.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in the parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*.The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. Cases that are relevant to the content of this chapter include Oak City and Gustavsson, AB.

Review questions

4.1 Why are indirect costs not directly traced to cost objects in the same way as direct costs? *(p. 88)*

4.2 Define cost tracing, cost allocation, allocation base and cost driver. *(p. 88)*

4.3 Distinguish between arbitrary and cause-and-effect allocations. *(p. 88)*

4.4 Explain how cost information differs for profit measurement/inventory valuation requirements compared with decision-making requirements. *(p. 89)*

4.5 Explain why cost systems should differ in terms of their level of sophistication. *(pp. 90–91)*

4.6 Describe the process of assigning direct labour and direct materials to cost objects. *(p. 91)*

4.7 Why are separate departmental or cost centre overhead rates preferred to a plant-wide (blanket) overhead rate? *(pp. 92–93)*

4.8 Describe the two-stage overhead allocation procedure. *(pp. 93–94)*

4.9 Why are some overhead costs sometimes not relevant for decision-making purposes? *(p. 102)*

4.10 Why are budgeted overhead rates preferred to actual overhead rates? *(p. 103)*

4.11 Give two reasons for the under- or over-recovery of overheads at the end of the accounting period. *(p. 104)*

Review problems

4.12 A company uses a predetermined overhead recovery rate based on machine hours. Budgeted factory overhead for a year amounted to £720 000, but actual factory overhead incurred was £738 000. During the year, the company absorbed £714 000 of factory overhead on 119 000 actual machine hours.

What was the company's budgeted level of machine hours for the year?

A 116 098
B 119 000
C 120 000
D 123 000

ACCA Foundation Paper 3

4.13 A company absorbs overheads on machine hours which were budgeted at 11 250 with overheads of £258 750. Actual results were 10 980 hours with overheads of £254 692.

Overheads were:

A under-absorbed by £2152
B over-absorbed by £4058
C under-absorbed by £4058
D over-absorbed by £2152

CIMA Stage 1

4.14 The following data are to be used for sub-questions (i) and (ii) below:

Budgeted labour hours	8500
Budgeted overheads	£148 750
Actual labour hours	7928
Actual overheads	£146 200

(i) Based on the data given above, what is the labour hour overhead absorption rate?

A £17.50 per hour
B £17.20 per hour
C £18.44 per hour
D £18.76 per hour

(ii) Based on the data given above, what is the amount of overhead under-over-absorbed?

A £2550 under-absorbed
B £2529 over-absorbed
C £2550 over-absorbed
D £7460 under-absorbed

CIMA Stage 1

4.15 J Ltd uses standard absorption costing and absorbs production overheads on the basis of standard machine hours. The following budgeted and actual information applied in its last accounting period:

	Budget	Actual
Production overhead	$180 000	$178 080
Machine hours	50 000	48 260
Units produced	40 000	38 760

At the end of the period, production overhead will be reported as

A under-absorbed by $4344.
B under-absorbed by $3660.
C over-absorbed by $4344.
D over-absorbed by $3660.

CIMA Management Accounting Fundamentals

4.16 A company has over-absorbed fixed production overheads for the period by £6000. The fixed production overhead absorption rate was £8 per unit and is based on the normal level of activity of 5000 units. Actual production was 4500 units.

What was the actual fixed production overheads incurred for the period?

A £30 000
B £36 000
C £40 000
D £42 000

ACCA Paper 1.2 – Financial Information for Management

4.17 A company absorbs overheads on machine hours. In a period, actual machine hours were 17 285, actual overheads were £496 500 and there was under-absorption of £12 520.

What was the budgeted level of overheads?

A £483 980
B £496 500
C £509 020
D It cannot be calculated from the information provided.

CIMA Stage 1 Cost Accounting

4.18 Canberra has established the following information regarding fixed overheads for the coming month:

Budgeted information:

Fixed overheads	£180 000
Labour hours	3 000
Machine hours	10 000
Units of production	5 000

Actual fixed costs for the last month were £160 000.

Canberra produces many different products using highly automated manufacturing processes and absorbs overheads on the most appropriate basis.

What will be the predetermined overhead absorption rate?

A £16
B £18
C £36
D £60

ACCA Paper 1.2 – Financial information for Management

4.19 The management accountant's report shows that fixed production overheads were over-absorbed in the last accounting period. The combination that is certain to lead to this situation is

	Production activity	and	Fixed overhead expenditure
A	lower than budget	and	higher than budget
B	higher than budget	and	higher than budget
C	as budgeted	and	as budgeted
D	higher than budget	and	lower than budget

CIMA – Management Accounting Fundamentals

4.20 An engineering firm operates a job costing system. Production overhead is absorbed at the rate of $8.50 per machine hour. In order to allow for non-production overhead costs and profit, a mark up of 60% of prime cost is added to the production cost when preparing price estimates.

The estimated requirements of job number 808 are as follows:

Direct materials	$10 650
Direct labour	$3 260
Machine hours	140

The estimated price notified to the customer for job number 808 will be

A $22 256 B $22 851 C $23 446 D $24 160

CIMA – Management Accounting Fundamentals

4.21 A company uses the repeated distribution method to reapportion service department costs. The use of this method suggests

A the company's overhead rates are based on estimates of cost and activity levels, rather than actual amounts.
B there are more service departments than production cost centres.
C the company wishes to avoid under- or over-absorption of overheads in its production cost centres.
D the service departments carry out work for each other.

CIMA – Management Accounting Fundamentals

4.22 The management accountant of Gympie Limited has already allocated and apportioned the fixed overheads for the period although she has yet to reapportion the service centre costs. Information for the period is as follows:

	Production departments		Service departments		Total
	1	2	Stores	Maintenance	
Allocated and apportioned	£17 500	£32 750	£6300	£8450	£65 000
Work done by:					
Stores	60%	30%	—	10%	
Maintenance	75%	20%	5%	—	

What are the total overheads included in production department 1 if the reciprocal method is used to reapportion service centre costs?

A £27 618
B £28 171
C £28 398
D £28 453

ACCA Paper 1.2 – Financial information for Management

4.23 **Overhead analysis and calculation of product costs**

A furniture-making business manufactures quality furniture to customers' orders. It has three production departments and two service departments. Budgeted overhead costs for the coming year are as follows:

	Total (£)
Rent and Rates	12 800
Machine insurance	6 000
Telephone charges	3 200
Depreciation	18 000
Production Supervisor's salaries	24 000
Heating, lighting	6 400
	70 400

The three production departments – A, B and C, and the two service departments – X and Y, are housed in the new premises, the details of which, together with other statistics and information, are given below.

	Departments				
	A	B	C	X	Y
Floor area occupied (sq. metres)	3000	1800	600	600	400
Machine value (£000)	24	10	8	4	2
Direct labour hrs budgeted	3200	1800	1000		
Labour rates per hour	£3.80	£3.50	£3.40	£3.00	£3.00
Allocated Overheads:					
Specific to each department (£000)	2.8	1.7	1.2	0.8	0.6
Service Department X's costs apportioned	50%	25%	25%		
Service Department Y's costs apportioned	20%	30%	50%		

Required:

(a) Prepare a statement showing the overhead cost budgeted for each department, showing the basis of apportionment used. Also calculate suitable overhead absorption rates.

(9 marks)

(b) Two pieces of furniture are to be manufactured for customers. Direct costs are as follows:

	Job 123	Job 124
Direct Material	£154	£108
Direct Labour	20 hours Dept A	16 hours Dept A
	12 hours Dept B	10 hours Dept B
	10 hours Dept C	14 hours Dept C

Calculate the total costs of each job.

(5 marks)

(c) If the firm quotes prices to customers that reflect a required profit of 25% on selling price, calculate the quoted selling price for each job.

(2 marks)

(d) If material costs are a significant part of total costs in a manufacturing company, describe a system of material control that might be used in order to effectively control costs, paying particular attention to the stock control aspect.

(9 marks)

(Total 25 marks)

AAT Stage 3 Cost Accounting and Budgeting

4.24 Calculation of product overhead costs

Bookdon Public Limited Company manufactures three products in two production departments, a machine shop and a fitting section; it also has two service departments, a canteen and a machine maintenance section. Shown below are next year's budgeted production data and manufacturing costs for the company.

	Product X	Product Y	Product Z
Production	4200 units	6900 units	1700 units
Prime cost:			
Direct materials	£11 per unit	£14 per unit	£17 per unit
Direct labour:			
Machine shop	£6 per unit	£4 per unit	£2 per unit
Fitting section	£12 per unit	£3 per unit	£21 per unit
Machine hours per unit	6 hours per unit	3 hours per unit	4 hours per unit

	Machine shop	Fitting section	Canteen	Machine maintenance section	Total
Budgeted overheads (£):					
Allocated overheads	27 660	19 470	16 600	26 650	90 380
Rent, rates, heat and light					17 000
Depreciation and insurance of equipment					25 000
Additional data:					
Gross book value of equipment (£)	150 000	75 000	30 000	45 000	
Number of employees	18	14	4	4	
Floor space occupied (square metres)	3 600	1 400	1 000	800	

It has been estimated that approximately 70% of the machine maintenance section's costs are incurred servicing the machine shop and the remainder incurred servicing the fitting section.

Required:

(a) (i) Calculate the following budgeted overhead absorption rates:

A machine hour rate for the machine shop.

A rate expressed as a percentage of direct wages for the fitting section.

All workings and assumptions should be clearly shown.

(12 marks)

(ii) Calculate the budgeted manufacturing overhead cost per unit of product X.

(2 marks)

(b) The production director of Bookdon PLC has suggested that 'as the actual overheads incurred and units produced are usually different from the budgeted and as a consequence profits of each month end are distorted by over- under-absorbed overheads, it would be more accurate to calculate the actual overhead cost per unit each month end by dividing the total number of all units actually produced during the month into the actual overheads incurred'.

Critically examine the production director's suggestion.

(8 marks)

(Total 22 marks)

ACCA Level 1 Costing

4.25 Calculation of overhead rates and under- over-recovery

A factory with three departments uses a single production overhead absorption rate, expressed as a percentage of direct wages cost. It has been suggested that departmental overhead absorption rates would result in more accurate job costs. Set out below are budgeted and actual data for the previous period, together with information relating to job no. 657.

		Direct wages (000s)	Direct labour hours	Machine hours	Production overheads (000s)
Budget:					
Department:	A	25	10 000	40 000	120
	B	100	50 000	10 000	30
	C	25	25 000	—	75
Total:		150	85 000	50 000	225
Actual:					
Department:	A	30	12 000	45 000	130
	B	80	45 000	14 000	28
	C	30	30 000	—	80
Total:		140	87 000	59 000	238

During this period job no. 657 incurred the actual costs and actual times in the departments as shown below:

		Direct material (£)	Direct wages (£)	Direct labour hours	Machine hours
Department:	A	120	100	20 000	40 000
	B	60	60	40 000	10 000
	C	10	10	10 000	—

After adding production overhead to prime cost, one-third is added to production cost for gross profit. This assumes that a reasonable profit is earned after deducting administration, selling and distribution costs. You are required to:

(a) calculate the current overhead absorption rate;

(b) using the rate obtained in (a) above, calculate the production overhead charged to job no. 657, and state the production cost and expected gross profit on this job;

(c) (i) comment on the suggestion that departmental overhead absorption rates would result in more accurate job costs; and
(ii) compute such rates, briefly explaining your reason for each rate;

(d) using the rates calculated in (c) (ii) above, show the overhead, by department and in total, that would apply to job no. 657;

(e) show the over- under-absorption, by department and in total, for the period, using:
(i) the current rate in your answer to (a) above; and
(ii) your suggested rates in your answers to (c) (ii) above.

(20 marks)

CIMA Cost Accounting 1

4.26 Make or buy decision

Shown below is next year's budget for the forming and finishing departments of Tooton Ltd. The departments manufacture three different types of component, which are incorporated into the output of the firm's finished products.

	Component		
	A	B	C
Production (units)	14 000	10 000	6 000
Prime cost (£ per unit):			
Direct materials			
Forming dept	8	7	9
Direct labour			
Forming dept	6	9	12
Finishing dept	10	15	8
	24	31	29
Manufacturing times (hours per unit):			
Machining			
Forming dept	4	3	2
Direct labour			
Forming dept	2	3	4
Finishing dept	3	10	2

	Forming department (£)	Finishing department (£)
Variable overheads	200 900	115 500
Fixed overheads	401 800	231 000
	£602 700	£346 500
Machine time required and available	98 000 hours	—
Labour hours required and available	82 000 hours	154 000 hours

The forming department is mechanized and employs only one grade of labour, the finishing department employs several grades of labour with differing hourly rates of pay.

Required:

(a) Calculate suitable overhead absorption rates for the forming and finishing departments for next year and include a brief explanation for your choice of rates.

(6 marks)

(b) Another firm has offered to supply next year's budgeted quantities of the above components at the following prices:

Component A £30 Component B £65
Component C £60

Advise management whether it would be more economical to purchase any of the above components from the outside supplier. You must show your workings and, considering cost criteria only, clearly state any assumptions made or any aspects that may require further investigation.

(8 marks)

(c) Critically consider the purpose of calculating production overheads absorption rates.

(8 marks)
(Total 22 marks)
ACCA Foundation Costing

4.27 Various overhead absorption rates and under- over-recovery

The following data relate to a manufacturing department for a period:

	Budget data (£)	Actual data (£)
Direct material cost	100 000	150 000
Direct labour cost	250 000	275 000
Production overhead	250 000	350 000
Direct labour hours	50 000 hours	55 000 hours

Job ZX was one of the jobs worked on during the period. Direct material costing £7000 and direct labour (800 hours) costing £4000 were incurred.

Required:

(i) Calculate the production overhead absorption rate predetermined for the period based on:
(a) percentage of direct material cost;
(b) direct labour hours.

(3 marks)

(ii) Calculate the production overhead cost to be charged to Job ZX based on the rates calculated in answer to (i) above.

(2 marks)

(iii) Assume that the direct labour hour rate of absorption is used. Calculate the under- or over-absorption of production overheads for the period and state an appropriate treatment in the accounts.

(4 marks)

(iv) Comment briefly on the relative merits of the two methods of overhead absorption used in (i) above.

(6 marks)
(Total 15 marks)
AAT Cost Accounting and Budgeting

4.28 Reapportionment of service department costs

A business operates with two production centres and three service centres. Costs have been allocated and apportioned to these centres as follows:

Production centres		Service centres		
1	2	A	B	C
£2000	£3500	£300	£500	£700

Information regarding how the service centres work for each other and for the production centres is given as:

	Work done for:				
	Production centres		Service centres		
	1	2	A	B	C
By A	45%	45%	—	10%	—
By B	50%	20%	20%	—	10%
By C	60%	40%	—	—	—

Information concerning production requirements in the two production centres is as follows:

	Centre 1	Centre 2
Units produced	1500 units	2000 units
Machine hours	3000 hours	4500 hours
Labour hours	2000 hours	6000 hours

Required:

(a) Using the reciprocal method calculate the total overheads in production centres 1 and 2 after reapportionment of the service centre costs.

(7 marks)

(b) Using the most appropriate basis establish the overhead absorption rate for production centre 1. Briefly explain the reason for your chosen absorption basis.

(3 marks)

(Total 10 marks)

ACCA Paper 1.2 – Financial Information for Management



Accounting entries for a job costing system

5

This chapter is concerned with the accounting entries necessary to record transactions within a job costing system. In Chapter 2 it was pointed out that job costing relates to a costing system that is required in organizations where each unit or batch of output of a product or service is unique. This creates the need for the cost of each unit to be calculated separately. The term 'job' thus relates to each unique unit or batch of output. In contrast, process costing relates to those situations where masses of identical units are produced and it is unnecessary to assign costs to individual units of output. Instead, the cost of a single unit of output can be obtained by merely dividing the total costs assigned to the cost object for a period by the units of output for that period. In practice these two costing systems represent extreme ends of a continuum. The output of many organizations requires a combination of the elements of both job costing and process costing. However, the accounting methods described in this chapter can be applied to all types of costing systems ranging from purely job to process, or a combination of both. In the next chapter we shall look at process costing in detail.

The accounting system on which we shall concentrate our attention is one in which the cost and financial accounts are combined in one set of accounts; this is known as an **integrated cost accounting system**. An alternative system, where the cost and financial accounts are maintained independently, is known as an **interlocking cost accounting system**. The integrated cost accounting system is generally considered to be preferable to the interlocking system, since the latter involves a duplication of accounting entries.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- record the accounting entries for an integrated and interlocking accounting system;
- distinguish between an integrated and an interlocking accounting system;
- explain the distinguishing features of contract costing;
- prepare contract accounts and calculate the profit attributable to each contract.

Control accounts

The recording system is based on a system of control accounts. A **control account** is a summary account, where entries are made from totals of transactions for a period. For example, the balance in the stores ledger control account will be supported by a voluminous file of stores ledger accounts, which will add up to agree with the total in the stores ledger control account. Assuming 1000 items of materials were received for a period that totalled £200 000, an entry of the total of £200 000 would be recorded on the debit (receipts side) of the stores ledger *control* account. This will be supported by 1000 separate entries in each of the individual stores ledger accounts. The total of all these *individual* entries will add up to £200 000. A system of control accounts enables one to check the accuracy of the various accounting entries, since the total of all the *individual* entries in the various stores ledger accounts should agree with the control account, which will have received the *totals* of the various transactions. The file of all the individual accounts (for example the individual stores ledger accounts) supporting the total control account is called the subsidiary ledger.

We shall now examine the accounting entries necessary to record the transaction outlined in Example 5.1. A manual system is described so that the accounting entries can be followed, but the normal practice is now for these accounts to be maintained on a computer. You will find a summary of the accounting entries set out in Exhibit 5.1, where each transaction is prefixed by the appropriate number to give a clearer understanding of the necessary entries relating to each transaction. In addition, the appropriate journal entry is shown for each transaction together with a supporting explanation.

Recording the purchase of raw materials

The entry to record the purchase of materials in transaction 1 is

Dr Stores ledger control account	182 000	
Cr Creditors control account		182 000

This accounting entry reflects the fact that the company has incurred a short-term liability to acquire a current asset consisting of raw material stock. Each purchase is also entered in the receipts column of an individual stores ledger account (a separate record is used for each item of materials purchases) for the quantity received, a unit price and amount. In addition, a separate credit entry is made in each individual creditor's account. Note that the entries in the control accounts form part of the system of double entry, whereas the separate entries in the individual accounts are detailed subsidiary records, which do not form part of the double entry system.

The entry for transaction 2 for materials returned to suppliers is

Dr Creditors control account	2000	
Cr Stores ledger control account		2000

An entry for the returned materials is also made in the appropriate stores ledger records and in the individual creditors' accounts.

EXAMPLE 5.1

The following are the transactions of AB Ltd for the month of April.

1. Raw materials of £182 000 were purchases on credit.
2. Raw materials of £2000 were returned to the supplier because of defects.
3. The total of stores requisitions for direct materials issued for the period was £165 000.
4. The total issues for indirect materials for the period was £10 000.
5. Gross wages of £185 000 were incurred during the period

consisting of wages paid to employees	£105 000
Tax deductions payable to the Government (i.e. Inland Revenue)	£60 000
National Insurance contributions due	£20 000

6. All the amounts due in transaction 5 were settled by cash during the period.
7. The allocation of the gross wages for the period was as follows:

Direct wages	£145 000
Indirect wages	£40 000

8. The employer's contribution for National Insurance deductions was £25 000.
9. Indirect factory expenses of £41 000 were incurred during the period.
10. Depreciation of factory machinery was £30 000.
11. Overhead expenses allocated to jobs by means of overhead allocation rates was £140 000 for the period.
12. Non-manufacturing overhead incurred during the period was £40 000.
13. The cost of jobs completed and transferred to finished goods stock was £300 000.
14. The sales value of goods withdrawn from stock and delivered to customers was £400 000 for the period.
15. The cost of goods withdrawn from stock and delivered to customers was £240 000 for the period.

Recording the issue of materials

The storekeeper issues materials from store in exchange for a duly authorized stores requisition. For direct materials the job number will be recorded on the stores requisition, while for indirect materials the overhead account number will be entered on the requisition. The issue of direct materials involves a transfer of the materials from stores to production. For transaction 3, material requisitions will have been summarized and the resulting totals will be recorded as follows:

Dr Work in progress account	165 000	
Cr Stores ledger control account		165 000

This accounting entry reflects the fact that raw material stock is being converted into work in progress (WIP) stock. In addition to the above entries in the control accounts, the individual jobs will be charged with the cost of the material issued so that job costs can be calculated. Each issue is also entered in the issues column on the appropriate stores ledger record.

EXHIBIT 5.1

Summary of accounting transactions for AB Ltd

Stores ledger control account

1. Creditors a/c	182 000	2. Creditors a/c	2 000
		3. Work in progress a/c	165 000
		4. Factory overhead a/c	10 000
		Balance c/d	5 000
	182 000		182 000
Balance b/d	5 000		

Factory overhead control account

4. Stores ledger a/c	10 000	11. Work in progress a/c	140 000
7. Wages control a/c	40 000	Balance – under recovery transferred to costing P&L a/c	6 000
8. National Insurance contributions a/c	25 000		
9. Expense creditors a/c	41 000		
10. Provision for depreciation a/c	30 000		
	146 000		146 000

Non-manufacturing overhead control account

12. Expense creditor a/c	40 000	Transferred to costing P&L a/c	40 000

Creditors account

2. Stores ledger a/c	2 000	1. Stores ledger a/c	182 000

Wages accrued account

6. Cash/bank	105 000	5. Wages control a/c	105 000

Tax payable account

6. Cash/bank	60 000	5. Wages control a/c	60 000

National Insurance contributions account

6. Cash/bank	20 000	5. Wage control a/c	20 000
8. Cash/bank	25 000	8. Factory overhead a/c	25 000
	45 000		45 000

Expense creditors account

		9. Factory overhead a/c	41 000
		12. Non-manufacturing overhead	40 000

Work in progress control account

3. Stores ledger a/c	165 000	13. Finished goods stock a/c	300 000
7. Wages control a/c	145 000	Balance c/d	150 000
11. Factory overhead a/c	140 000		
	450 000		450 000
Balanced b/d	150 000		

Finished goods stock account

13. Work in progress a/c	300 000	15. Cost of sales a/c	240 000
		Balance c/d	60 000
	300 000		300 000
Balance b/d	60 000		

Cost of sales account

15. Finished goods stock a/c	240 000	Transferred to costing P&L a/c	240 000

Provision for depreciation account

		10. Factory overhead	30 000

Wages control account

5. Wages accrued a/c	105 000	7. Work in progress a/c	145 000
5. Tax payable a/c	60 000	7. Factory overhead a/c	40 000
5. National Insurance a/c	20 000		
	185 000		185 000

Sales account

Transferred to costing P&L	400 000	14. Debtors	400 000

Debtors account

14. Sales a/c	400 000		

Costing profit and loss account

Sales a/c		400 000
Less cost of sales a/c		240 000
Gross profit		160 000
Less under recovery of factory overhead	6 000	
Non-manufacturing overhead	40 000	46 000
Net profit		114 000

The entry for transaction 4 for the issue of indirect materials is

Dr Factory overhead control account	10 000	
Cr Stores ledger control account		10 000

In addition to the entry in the factory overhead account, the cost of material issued will be entered in the individual overhead accounts. These separate overhead accounts will normally consist of individual indirect material accounts for each responsibility centre. Periodically, the totals of each responsibility centre account for indirect materials will be entered in performance reports for comparison with the budgeted indirect material cost.

After transactions 1–4 have been recorded, the stores ledger control account would look like this:

Stores ledger control account

1. Creditors a/c	182 000	2. Creditors a/c	2 000
		3. Work in progress a/c	165 000
		4. Factory overhead a/c	10 000
		Balance c/d	5 000
	182 000		182 000
Balance b/d	5 000		

Accounting procedure for labour costs

Accounting for labour costs can be divided into the following two distinct phases:

1. Computations of the gross pay for each employee and calculation of payments to be made to employees, government, pension funds, etc. (**payroll accounting**).
2. Allocation of labour costs to jobs, overhead account and capital accounts (**labour cost accounting**).

An employee's gross pay is computed from information on the employee's personal record, and attendance or production records. For each employee a separate record is kept, showing the employee's employment history with the company, current rate of pay and authorized deductions such as National Insurance, pension plans, savings plans, union dues and so on. The gross wages are calculated from these documents, and an entry is then made in the payroll for each employee, showing the gross pay, tax deductions and other authorized deductions. The gross pay less the deductions gives the net pay, and this is the amount of cash paid to each employee.

The payroll gives details of the total amount of cash due to employees and the amounts due to the Government (i.e. Inland Revenue), Pension Funds and Savings Funds, etc. To keep the illustration simple at this stage, transaction 5 includes only deductions in respect of taxes and National Insurance. The accounting entries for transaction 5 are

Dr Wages control account	185 000	
Cr Tax payable account		60 000
Cr National Insurance contributions account		20 000
Cr Wages accrued account		105 000

The credit entries in transaction 5 will be cleared by a payment of cash. The payment of wages will involve an immediate cash payment, but some slight delay may occur with the payment of tax and National Insurance since the final date for payment of these items is normally a few weeks after the payment of wages. The entries for the cash payments for these items (transaction 6) are

Dr Tax payable account	60 000	
Dr National Insurance contributions account	20 000	
Dr Wages accrued account	105 000	
Cr Cash/bank		185 000

Note that the credit entries for transaction 5 merely represent the recording of amounts due for future payments. The wages control account, however, represents the gross wages for the period, and it is the amount in this account that must be allocated to the job, overhead and capital accounts. Transaction 7 gives details of the allocation of the gross wages. The accounting entries are

Dr Work in progress control account	145 000	
Dr Factory overhead control account	40 000	
Cr Wages control account		185 000

In addition to the total entry in the work in progress control account, the labour cost will be charged to the individual job accounts. Similarly, the total entry in the factory overhead control account will be supported by an entry in each individual overhead account for the indirect labour cost incurred.

Transaction 8 represents the employer's contribution for National Insurance payments. The National Insurance deductions in transaction 5 represent the employees' contributions where the company acts merely as an agent, paying these contributions on behalf of the employee. The employer is also responsible for making a contribution in respect of each employee. To keep the accounting entries simple here, the employer's contributions will be charged to the factory overhead account. The accounting entry for transaction 8 is therefore:

Dr Factory overhead control account	25 000	
Cr National Insurance contributions account		25 000

The National Insurance contributions account will be closed with the following entry when the cash payment is made:

Dr National Insurance contributions account	25 000	
Cr Cash/bank		25 000

After recording these transactions, the wages control account would look like this:

Wages control account

5. Wages accrued a/c	105 000	7. Work in progress a/c	145 000
5. Tax payable a/c	60 000	7. Factory overhead a/c	40 000
5. National Insurance a/c	20 000		
	185 000		185 000

Accounting procedure for manufacturing overheads

Accounting for manufacturing overheads involves entering details of the actual amount of manufacturing overhead incurred on the debit side of the factory overhead control account. The total amount of overheads charged to production is recorded on the credit side of the factory overhead account. In the previous chapter we established that manufacturing overheads are charged to production using budgeted overhead rates. It is most unlikely, however, that the actual amount of overhead incurred, which is recorded on the debit side of the account, will be in agreement with the amount of overhead allocated to jobs, which is recorded on the credit side of the account. The difference represents the under- or over-recovery of factory overheads, which is transferred to the profit and loss account, in accordance with the requirements of the UK Statement of Standard Accounting Practice (SSAP9) and the International Accounting Standard (IAS9) on inventory valuation.

Transaction 9 represents various indirect expenses that have been incurred and that will eventually have to be paid in cash, for example property taxes and lighting and heating. Transaction 10 includes other indirect expenses that do not involve a cash commitment. For simplicity it is assumed that depreciation of factory machinery is the only item that falls into this category. The accounting entries for transactions 9 and 10 are

Dr Factory overhead control account	71 000	
Cr Expense creditors control account		41 000
Cr Provision of depreciation account		30 000

In addition, subsidiary entries, not forming part of the double entry system, will be made in individual overhead accounts. These accounts will be headed by the title of the cost centre followed by the object of expenditure. For example, it may be possible to assign indirect materials directly to specific cost centres, and separate records can then be kept of the indirect materials charge for each centre. It will not, however, be possible to allocate property taxes, lighting and heating directly to cost centres, and entries should be made in individual overhead accounts for these items.

Transaction 11 refers to the total overheads that have been charged to jobs using the estimated overhead absorption rates. The accounting entry in the control accounts for allocating overheads to jobs is

Dr Work in progress control account	140 000	
Cr Factory overhead control account		140 000

In addition to this entry, the individual jobs are charged so that job costs can be calculated. When these entries have been made the factory overhead control account would look like this:

Factory overhead control account

4.	Stores ledger control a/c	10 000	11.	Work in progress control a/c	140 000
7.	Wages control a/c	40 000		Balance – Under-recovery of overhead transferred to costing profit and loss a/c	6 000
8.	Employer's National Insurance contributions a/c	25 000			
9.	Expense creditors a/c	41 000			
10.	Provision for depreciation a/c	30 000			
		146 000			146 000

The debit side of this account indicates that £146 000 overhead has been incurred, but examination of the credit side indicates that only £140 000 has been allocated to jobs via overhead allocation rates. The balance of £6000 represents an under-recovery of factory overhead, which is regarded as a period cost to be charged to the costing profit and loss account in the current accounting period. The reasons for this were explained in the previous chapter.

Non-manufacturing overheads

You will have noted in the previous chapter that non-manufacturing overhead costs are regarded as period costs and not product costs, and non-manufacturing overheads are not therefore charged to the work in progress control account. The accounting entry for transaction 12 is

Dr Non-manufacturing overheads account	40 000	
Cr Expense creditors account		40 000

At the end of the period the non-manufacturing overheads will be transferred to the profit and loss account as a period cost by means of the following accounting entry:

Dr Profit and loss account	40 000	
Cr Non-manufacturing overheads account		40 000

In practice, separate control accounts are maintained for administrative, marketing and financial overheads, but, to simplify this example, all the non-manufacturing overheads are included in one control account. In addition, subsidiary records will be kept that analyse the total non-manufacturing overheads by individual accounts, for example office stationery account, sales person's travelling expenses account, etc.

Note that these accounts do not form part of the double entry system, but represent a detailed breakdown of the total entries included in the non-manufacturing overhead control account.

Accounting procedures for jobs completed and products sold

When jobs have been completed, they are transferred from the factory floor to the finished goods store. The total of the job accounts for the completed jobs for the period is recorded as a transfer from the work in progress control account to the finished goods stock account. The accounting entry for transaction 13 is

Dr Finished goods stock account	300 000	
Cr Work in progress control account		300 000

When the goods are removed from the finished goods stock and delivered to the customers, the revenue is recognized. It is a fundamental principle of financial accounting that only costs associated with earning the revenue are included as expenses. The cost of those goods that have been delivered to customers must therefore be matched against the revenue due from delivery of the goods so that the gross profit can be calculated. Any goods that have not been delivered to customers will be included as part of the finished stock valuation. The accounting entries to reflect these transactions are:

Transaction 14		
Dr Debtors control account	400 000	
Cr Sales account		400 000
Transaction 15		
Dr Cost of sales account	240 000	
Cr Finished goods stock account		240 000

Costing profit and loss account

At frequent intervals management may wish to ascertain the profit to date for the particular period. The accounting procedure outlined in this chapter provides a database from which a costing profit and loss account may easily be prepared. The costing profit and loss account for AB Ltd based on the information given in Example 5.1 is set out in Exhibit 5.1 shown on page 132. As cost control procedures should exist at cost (responsibility) centre levels, management may find the final profit calculation sufficient when it is combined with a summary of the various performance reports. Alternatively, management may prefer the profit statement to be presented in a format similar to that which is necessary for external reporting. Such information can easily be extracted from the subsidiary records. For example, the factory and non-manufacturing overhead control accounts are supported by detailed individual accounts such as factory depreciation, factory lighting and heating, office salaries and so on. The items in the costing profit and loss account can therefore be easily replaced with those items normally presented in the financial accounts by extracting from the subsidiary records the appropriate information. The accounting procedure outlined in Exhibit 5.1, however, provides the database for ascertaining the job costs and stock valuations that are essential to external reporting. In addition, information in the subsidiary records provides the data from which the accountant can extract relevant decision-making and control information to suit the needs of the various users of accounting information.

Interlocking accounting

With an **interlocking cost accounting system** the cost and financial accounts are maintained independently of each other, and in the cost accounts no attempt is made to keep a separate record of the financial accounting transactions. Examples of financial accounting transactions include entries in the various creditors, debtors and capital accounts. To maintain the double entry records, an account must be maintained in the cost accounts to record the corresponding entry that, in an integrated accounting system, would normally be made in one of the financial accounts (creditors, debtors accounts, etc.). This account is called a cost control or general ledger adjustment account.

Using an interlocking accounting system to record the transactions listed in Example 5.1, the entries in the creditors, wages accrued, taxation payable, National Insurance contributions, expense creditors, provision for depreciation and debtors accounts would be replaced by the following entries in the cost control account:

Cost control account

2.	Stores ledger control a/c	2 000	1.	Stores ledger control a/c	182 000
14.	Sales a/c	400 000	5.	Wages control a/c	185 000
	Balance c/d	215 000	8.	Factory overhead control a/c	25 000
			9.	Expense creditors a/c	41 000
			12.	Non-manufacturing overhead a/c	40 000
			10.	Factory overhead a/c	30 000
				Profit and loss a/c (profit for period)	114 000
		617 000			617 000
				Balance b/d	215 000

The entries in the remaining accounts will be unchanged.

For a detailed answer to an interlocking accounts question you should refer to the solution to Review problem 5.17. Sometimes examination questions are set that require you to reconcile the profit that has been calculated in the cost accounts with the profits calculated in the financial accounts. Most firms use an integrated accounting system, and hence there is no need to reconcile a separate set of cost and financial accounts. The reconciliation of cost and financial accounts is not therefore dealt with in this book. For an explanation of the reconciliation procedure you should refer to the solution to Review problem 5.19.

Contract costing

Contract costing is a system of job costing that is applied to relatively large cost units, which normally take a considerable length of time to complete. Building and construction work, civil engineering and shipbuilding are some examples of industries where large contract work is undertaken, and where contract costing is appropriate.

A contract account is maintained for each contract. All the direct costs of the contract are debited to the specific contract and overheads are apportioned in the

manner prescribed in Chapter 4. The contract price is credited to the contract account, and each contract account therefore becomes a small profit and loss account.

Because of the considerable length of time that is taken to complete a contract, it is necessary to determine the profit to be attributed to each accounting period. Financial accounting normally recognizes revenue when the goods are delivered, but such an approach is inappropriate for long-term contracts, since profits on large contracts would not be reported until they were completed. The profit and loss account would not reflect a fair view of the profitability of the company during the year but would show only the results of contracts that had been completed before the year end. To overcome this problem, it is preferable to take credit for profit while contracts are in progress.

The UK Statement of Standard Accounting Practice on Stocks and Work in Progress (SSAP 9) provides the following guidance on the attributable profit to be taken up for a particular period:

> *Where the business carries out long-term contracts and it is considered that their outcome can be assessed with reasonable certainty before their conclusion, the attributable profit should be calculated on a prudent basis and included in the accounts for the period under review. The profit taken up needs to reflect the proportion of the work carried out at the accounting date and to take into account any known inequalities of profitability in the various stages of a contract. The procedure to recognize profit is to include an appropriate proportion of total contract value as turnover in the profit and loss account as the contract activity progresses. The costs incurred in reaching that stage of completion are matched with this turnover, resulting in the reporting of results that can be attributed to the proportion of work completed.*
>
> *Where the outcome of long-term contracts cannot be assessed with reasonable certainty before the conclusion of the contract, no profit should be reflected in the profit and loss account in respect of those contracts although, in such circumstances, if no loss is expected it may be appropriate to show as turnover a proportion of the total contract value using a zero estimate of profit.*
>
> *If it is expected that there will be a loss on a contract as a whole, all of the loss should be recognized as soon as it is foreseen (in accordance with the prudence concept).*

Let us now prepare some contract accounts and determine the attributable profit to be taken up for an accounting period. Consider Example 5.2.

Before we compile the accounts, some of the terms used in Example 5.2 require an explanation. A customer is likely to be required under the terms of the contract to make **progress payments** to the contractor throughout the course of the work. The amount of the payments will be based on the sales value of the work carried out, as assessed by the architect or surveyor in the **architect's certificate**. A certificate provides confirmation that work to a certain sales value has been completed, and that some payment to the contractor is now due. The amount of the progress payment will consist of:

1. the sales value of work carried out and certified by the architect; less
2. a retention; less
3. the payments made to date.

So if the architect's certificates assess the value of work carried out to be £300 000 and if the retention is 10%, and if £230 000 has already been paid in progress payments, the current payment will be

£300 000 – £30 000 retention – £230 000 previous payment = £40 000

EXAMPLE 5.2

A construction company is currently undertaking three separate contracts and information relating to these contracts for the previous year, together with other relevant data, are shown below:

	Contract A (£000)	Contract B (£000)	Contract C (£000)
Contract price	1760	1485	2420
Balances b/fwd at beginning of year:			
Material on site	—	20	30
Written-down value of plant and machinery	—	77	374
Wages accrued	—	5	10
Transactions during previous year:			
Profit previously transferred to profit and loss a/c	—	—	35
Cost of work certified (cost of sales)	—	418	814
Transactions during current year:			
Materials delivered to sites	88	220	396
Wages paid	45	100	220
Salaries and other costs	15	40	50
Written-down value of plant issued to sites	190	35	—
Head office expenses apportioned during the year	10	20	50
Balances c/fwd at the end of year:			
Material on site	20	—	—
Written-down value of plant and machinery	150	20	230
Wages accrued	5	10	15
Value of work certified at end of year	200	860	2100
Cost of work not certified at end of year	—	—	55

The agreed retention rate is 10% of the value of work certified by the contractee's architects. Contract C is scheduled for handing over to the contractee in the near future, and the site engineer estimates that the extra costs required to complete the contract, in addition to those tabulated above, will total £305 000. This amount includes an allowance for plant depreciation, construction services and for contingencies.

You are required to prepare a cost account for each of the three contracts and recommend how much profit or loss should be taken up for the year.

There is frequently a contract clause which entitles the customer to withhold payment of **retention money** for a proportion of the value of work certified for a specified period after the end of the contract. During this period, the contractor must make good all contractual defects. When the defects have been satisfactorily completed the customer will release the retention money.

Let us now prepare the cost accounts from the information contained in Example 5.2 for contracts A, B and C:

Contract accounts

	A (£000)	B (£000)	C (£000)		A (£000)	B (£000)	C (£000)
				Wages accrued b/fwd		5	10
Materials on site b/fwd		20	30	Materials on site c/fwd	20		
Plant on site b/fwd		77	374	Plant on site c/fwd	150	20	230
Materials control a/c	88	220	396	Cost of work not certified c/fwd			55
Wages control a/c	45	100	220				
Salaries	15	40	50	Cost of sales – current period (balance) c/fwd	183	497	840
Plant control a/c	190	35					
Apportionment of head office expenses	10	20	50				
Wages accrued c/fwd	5	10	15				
	353	522	1135		353	522	1135
Cost of sales b/fwd	183	497	840	Attributable sales revenue (current period)*	183	442	1122
Profit taken this period			282	Loss taken		55	
	183	497	1122		183	497	1122
Cost of work not certified b/fwd			55	Wages accrued b/fwd	5	10	15
Materials on site b/fwd	20						
Plant on site b/fwd	150	20	230				

*Profit taken plus cost of sales for the current period or cost of sales less loss to date.

You will see that the contract accounts are divided into three sections. The objective of the first section is to determine the costs that should be included in the cost of sales for the purposes of calculating the profit taken up for the period. The balance shown in the first section of the contract accounts represents the **cost of sales** (also known as **cost of work certified**) attributable to each of the contracts.

You should note that unexpired costs such as the cost of work not certified and the written-down balance of the plant at the end of the period are carried forward to the third section of the contract accounts. This section represents the unexpired costs of the current period which will become an expired cost in future periods. The third section of the account should therefore be regarded as a future cost section.

In the second section of the contract accounts the period cost of sales is compared with the sales revenue that is estimated to be attributable to the contracts. The sales revenues attributable to the contracts for each period are estimated by adding the attributable profit taken up for the current period to the cost of sales for the current period (or cost of sales less the loss where a contract is currently running at a loss). The profits/losses on the three contracts to date are calculated by deducting the cost of sales (consisting of the sum of the cost of sales for the current and previous periods) from the value of work certified:

	(£000)	
Contract A	17	(£200–£183)
Contract B	(55)	(£860–£915)
Contract C	446	(£2100–£1654)

However, these profits/(losses) do not necessarily represent the profits/(losses) taken up on the contracts. According to SSAP 9, the concept of prudence should be applied when determining the profits/(losses) taken up on contracts. You are recommended to adopt the following guidelines:

1. If the contract is in its early stages, no profit should be taken. Profit should only be taken when the outcome of the contract can be assessed with reasonable certainty. You will see from Example 5.2 that the contract price for Contract A is £1 760 000, but the value of work certified is only £200 000. The contract is therefore approximately one-eighth complete, and it is unlikely that the outcome of the contract can be foreseen with reasonable certainty. Despite the fact that the profit to date is £17 000, it is recommended that no profit be taken.
2. If a loss is incurred, the prudence concept should be applied, and the total loss should be recognized in the period in which it is incurred. Consequently, the loss of £55 000 on Contract B is recognized in the current accounting period. Where further additional future losses are anticipated, all of the loss should be recognized as soon as it is foreseen and added to the cost of sales. In addition, the foreseeable loss should be shown in the balance sheet under the heading 'Provision/accrual for foreseeable losses'.
3. If the contract is nearing completion, the size of the eventual profit should be foreseen with reasonable certainty, and there is less need to be excessively prudent in determining the amount of profit to be recorded in the profit and loss account. With regard to Contract C, the value of work certified is approximately 87% of the contract price, and the **anticipated profit** is calculated as follows:

	(£000)
Cost of work certified (cost of sales to date = 814 + 840)	1654
Cost of work not certified	55
Estimated costs to complete	305
Estimated cost of contract	2014
Contract price	2420
Anticipated profit	406

The profit taken is calculated using the following formula:

$$\text{cash received to date} \frac{(0.90 \times £2100)}{\text{contract price } (£2420)} \times \text{estimated profit from the contract } (£406) = £317\,000$$

You should note that other more prudent approaches are sometimes used to determine the profit earned to date. The profit for the current period consists of the profit to date (£317 000) less the profit of £35 000 previously transferred to the profit and loss account. The profit taken to the profit and loss account for the current period is therefore £282 000.

4. Where substantial costs have been incurred on a contract, and it is not nearing completion (say it is in the region of 35–85% complete), the following formula is often used to determine the attributable profit to date:

$$\text{profit taken} = 2/3 \times \text{notional profit} \times \frac{\text{cash received}}{\text{value of work certified}}$$

This formula is one of several approaches that can be used to apply the prudence concept. Estimates of anticipated profit are likely to be inaccurate when contracts are not near to completion. To overcome this problem, **notional profit** should be used instead of anticipated profit. Notional profit is the value of work certified to date less the cost of work certified (that is, cost of sales) to date less a provision for any anticipated unforeseen eventualities.

Note than for Contract C £35 000 profit was recognized in the previous period and cost of sales of £814 000 was recorded. Therefore attributable sales revenue of £849 000 (£814 000 + £35 000) would have been recorded in the contract account for the *previous* period. For Contract B, no profits were recognized in the *previous period* and attributable sales for the period will thus be identical to the cost of sales (£418 000). Contract A commenced in the current period and so no transactions will have been recorded in the previous period. The debit side of the debtors accounts will be as follows:

	Contract A (£000)	Contract B (000)	Contract C (£000)
Previous period – attributable sales	—	418	849
Current period – attributable sales	183	442	1122
Total to date	183	860	1971

Work in progress valuation and amounts recoverable on contracts

The UK Statement of Standard Accounting Practice on Stocks on Work in Progress (SSAP 9) requires that the proportion of the total contract value appropriate to the stage of completion reached at balance sheet date be recognized as sales revenue. The costs relating to that completed work are included in the cost of sales. Any further costs that are attributable to the contract but that have not been included in the cost of sales are included at cost in the balance sheet and separately disclosed as 'Long-term contract balances' under the balance sheet heading 'Stocks'.

The associated balance sheet item for the contract value that is recorded as sales is debtors. The debtors balance is calculated by deducting progress payments received on account from the amount recognized as sales. This balance is included as a separate item within debtors and described as 'Amounts recoverable on contracts'. The balance sheet entries for Example 5.2 are as follows:

	Contract A (£000)	Contract B (£000)	Contract C (£000)	
Stocks:				
Total costs incurred to date	183	860	1709	(814 + 840 + 55)
Included in cost of sales	183	860	1654	
Included in long-term contract balances	0	0	55	
Debtors				
Cumulative sales turnover	183	860	1971	
Less cumulative progress payments	180	774	1890	
Amounts recoverable on contracts	3	86	81	

For Contract B, the total costs incurred to date are £915 000 (£418 000 + £497 000) but £55 000 of these costs have been recognized as a loss in the current period, so that cumulative cost of sales to be matched against cumulative sales is £860 000 (£915 000 – £55 000). Note also that the cumulative progress payments are 90% of the value of work certified and that the loss on Contract B has been charged to the current period. Other balance sheet entries will include the following:

	(£000)
Materials on site	20
Plant on site	400
Accruals	30

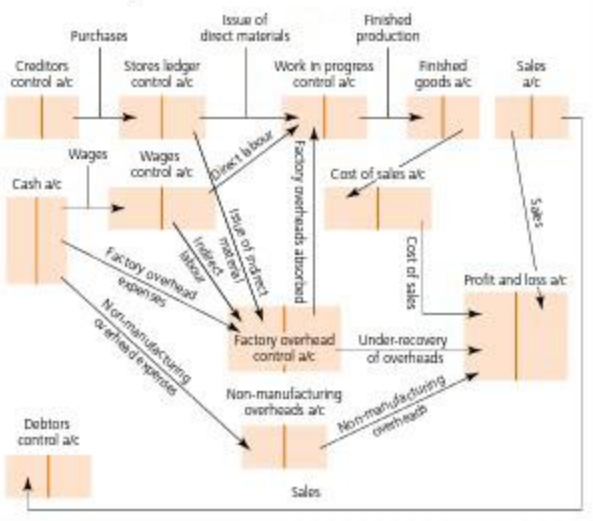


Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Record the accounting entries for an integrated and interlocking accounting system.** A summary of the accounting entries for an integrated accounting system, where all purchases and expenses are settled in cash, is shown diagrammatically in Figure 5.1.

FIGURE 5.1 *Flow of accounting entries in an integrated accounting system*



- **Distinguish between an integrated and an interlocking cost accounting system.**

  With an integrated costing accounting system, the cost and financial accounts are combined in one set of accounts whereas the cost and financial accounts are maintained independently with an interlocking accounting system. An integrated accounting system is recommended since it avoids the duplication of accounting entries.

- **Explain the distinguishing features of contract costing.**

  Contract costing is a system of job costing that is applied to relatively large cost units, which normally take a considerable time to complete (normally in excess of one year). It is applied in the building and construction, civil engineering and shipbuilding industries. Where contract costing is not applied, sales revenues are normally recognized for determining profits when the goods are received or the service has been completed. With a contract costing system sales revenues are attributed to the contract based on the proportion of work carried out to date.

- **Prepare contract accounts and calculate the profit attributable to each contract.**

  A contract account is maintained for each contract. Each contract account represents a separate profit and loss account. Typically contract accounts consist of three sections. The objective of the first section is to determine the costs that should be included in the cost of sales attributable to the contract. In the second section the period cost of sales is compared with the sales revenue that is estimated to be attributable to the contracts so that the profit can be derived. The third section represents the unexpired costs of the current period that will become expenses in future periods. The preparation of contract accounts and the calculation of attributable profit were illustrated using the data presented in Example 5.2.



Key terms and concepts

anticipated profit (p. 143)
architect's certificate (p. 140)
contract costing (p. 139)
control account (p. 130)
cost of sales (p. 142)
cost of work certified (p. 142)
integrated cost accounting system (p. 129)
interlocking cost accounting system (p. 129)
labour cost accounting (p. 134)
notional profit (p. 144)
payroll accounting (p. 134)
progress payments (p. 140)
retention money (p. 141)

Key examination points

Examination questions set by the professional accountancy examination bodies require the preparation of accounts for both integrated and interlocking accounting systems (see answers to Review problems 5.17 and 5.18 for examples). You may also be required to reconcile the cost and financial accounts. For an illustration of a reconciliation see the answer to Review problem 5.19). However, the reconciliation of cost and financial accounts is a topic that tends to be examined only on rare occasions.

Students often experience difficulty in recommending the amount of profit to be taken during a period for long-term contracts. Make sure you are familiar with the

four recommendations listed on pages 143–44 and that you can apply these recommendations to Review problems 5.20 and SM5.3 and 5.4 in the Student's Manual that can be accessed on the accompanying website.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

5.1 Distinguish between an integrated and interlocking accounting system. (*p. 129*)

5.2 Explain the purpose of control accounts. (*p. 130*)

5.3 List the accounting entries for the purchase of issues of direct and indirect materials. (*pp. 130–31*)

5.4 List the accounting entries for the payment and the allocation of gross wages. (*pp. 134–5*)

5.5 List the accounting entries for the payment and the allocation of overheads. (*pp. 136–7*)

5.6 Explain the major features of contract costing. (*pp. 139–40*)

5.7 Define progress payments, architect's certificates, retention money, cost of work certified and notional profit. (*pp. 140–44*)

5.8 Describe the four guidelines that should be used to determine the amount of profit that should be taken for a contract during a specific period. *(pp. 143–4)*

Review problems

5.9 A company operates an integrated cost and financial accounting system.

The accounting entries for the return of unused direct materials from production would be:

A	DR Work-in-progress account;	CR Stores control account.
B	DR Stores control account;	CR Work-in-progress account.
C	DR Stores control account;	CR Finished goods account.
D	DR Cost of sales account;	CR Work-in-progress account.

CIMA Stage 1 – Cost Accounting and Quantitative Methods

5.10 At the end of a period, in an integrated cost and financial accounting system, the accounting entries for overhead over-absorbed would be:

A	DR Profit and loss account	CR Work-in-progress control account
B	DR Profit and loss account	CR Overhead control account
C	DR Work-in-progress control account	CR Overhead control account
D	DR Overhead control account	CR Profit and loss account

CIMA Stage 1 – Cost Accounting and Quantitative Methods

5.11 In an interlocking accounting system, the profit shown in the financial accounts was £79 252 but the cost accounts showed £74 294 profit.

The following stock valuations were the only differences between the two sets of accounts:

Stock valuations	Cost accounts	Financial accounts
Opening stock	£10 116	£9 217
Closing stock	£24 053	X

What was the value of X?

A £18 196 B £23 154 C £24 952 D £28 112

CIMA Stage 1 – Cost Accounting and Quantitative Methods

5.12 The following data have been taken from the books of CB plc, which uses a non-integrated accounting system:

	Financial accounts £	Cost accounts £
Opening stock of materials	5000	6400
Closing stock of materials	4000	5200
Opening stock of finished goods	9800	9600
Closing stock of finished goods	7900	7600

The effect of these stock valuation differences on the profit reported by the financial and cost accounting ledgers is that:

A the financial accounting profit is £300 greater than the cost accounting profit.
B the financial accounting profit is £2100 greater than the cost accounting profit.
C the cost accounting profit is £300 greater than the financial accounting profit.
D the cost accounting profit is £900 greater than the financial accounting profit.
E the cost accounting profit is £2100 greater than the financial accounting profit.

CIMA Stage 2 – Operational Cost Accounting

5.13 The profits shown in the financial accounts was £158 500 but the cost accounts showed a different figure. The following stock valuations were used:

Stock valuations	Cost accounts	Financial accounts
	(£)	(£)
Opening stock	35 260	41 735
Closing stock	68 490	57 336

What was the profit in the cost accounts?

A £163 179
B £140 871
C £176 129
D £153 821

CIMA Stage 1

5.14 A construction company has the following data concerning one of its contracts:

Contract price	£2 000 000
Value certified	£1 300 000
Cash received	£1 200 000
Costs incurred	£1 050 000
Cost of work certified	£1 000 000

The profit (to the nearest £1000) to be attributed to the contract is

A £250 000
B £277 000
C £300 000
D £950 000
E £1 000 000

CIMA Stage 2

5.15 The following statements relate to long-term contracts:

(i) Levels of completion of the contract can be estimated using either costs to date or work certified to date.
(ii) Any anticipated losses should be taken as soon as they are expected.
(iii) If the contract is half complete it is expected that half the expected profit will always be taken.

Which of the above are correct?

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

5.16 The following could relate to contract costing:

(i) Work is for a period of long duration.
(ii) Progress payments are amounts paid for the contract throughout the course of the contract.
(iii) Architects' certificates are provided to establish the amount of work certified.

Which of the above are correct?

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

5.17 Interlocking accounts

CD Ltd, a company engaged in the manufacture of specialist marine engines, operates a historic job cost accounting system that is not integrated with the financial accounts.

At the beginning of May 2000 the opening balances in the cost ledger were as follows:

	(£)
Stores ledger control account	85 400
Work in progress control account	167 350
Finished goods control account	49 250
Cost ledger control account	302 000

During the month, the following transactions took place:

	(£)
Materials:	
Purchases	42 700
Issues to production	63 400
to general maintenance	1 450
to construction of manufacturing equipment	7 650
Factory wages:	
Total gross wages paid	124 000

£12 500 of the above gross wages were incurred on the construction of manufacturing equipment, £35 750 were indirect wages and the balance was direct.

Production overheads: the actual amount incurred, excluding items shown above, was £152 350; £30 000 was absorbed by the manufacturing equipment under construction and under-absorbed overhead written off at the end of the month amounted to £7550.

Royalty payments: one of the engines produced is manufactured under licence. £2150 is the amount that will be paid to the inventor for the month's production of that particular engine.

Selling overheads: £22 000.

Sales: £410 000.

The company's gross profit margin is 25% on factory cost.

At the end of May stocks of work in progress had increased by £12 000. The manufacturing equipment under construction was completed within the month, and transferred out of the cost ledger at the end of the month.

Required:

Prepare the relevant control accounts, costing profit and loss account, and any other accounts you consider necessary to record the above transactions in the cost ledger for May 2000.

(22 marks)
ACCA Foundation Costing

5.18 Integrated accounts

In the absence of the accountant you have been asked to prepare a month's cost accounts for a company which operates a batch costing system fully integrated with the financial accounts. The cost clerk has provided you with the following information, which he thinks is relevant:

	(£)
Balances at beginning of month:	
Stores ledger control account	24 175
Work in progress control account	19 210
Finished goods control account	34 164
Prepayments of production overheads brought forward from previous month	2 100

	(£)
Transactions during the month:	
Materials purchased	76 150
Materials issued: to production	26 350
for factory maintenance	3 280
Materials transferred between batches	1 450

	Direct workers (£)	Indirect workers (£)
Total wages paid:		
Net	17 646	3 342
Employees deductions	4 364	890
Direct wages charged to batches from work tickets	15 236	
Recorded non-productive time of direct workers	5 230	
Direct wages incurred on production of capital equipment, for use in the factory	2 670	
Selling and distribution overheads incurred	5 240	
Other production overheads incurred	12 200	
Sales	75 400	
Cost of finished goods sold	59 830	
Cost of goods completed and transferred into finished goods store during the month	62 130	
Physical stock value of work in progress at end of month	24 360	

The production overhead absorption rate is 150% of direct wages, and it is the policy of the company to include a share of production overheads in the cost of capital equipment constructed in the factory.

Required:

(a) Prepare the following accounts for the month:
stores ledger control account
wages control account
work in progress control account
finished goods control account
production overhead control account
profit/loss account.

(12 marks)

(b) Identify any aspects of the accounts which you consider should be investigated.

(4 marks)

(c) Explain why it is necessary to value a company's stocks at the end of each period and also why, in a manufacturing company, expense items such as factory rent, wages of direct operatives, power costs, etc. are included in the value of work in progress and finished goods stocks.

(6 marks)
(Total 22 marks)
ACCA Level 1 Costing

5.19 Reconciliation of cost and financial accounts

K Limited operates separate cost accounting and financial accounting systems. The following manufacturing and trading statement has been prepared from the financial accounts for the *quarter* ended 31 March:

	(£)	(£)
Raw materials:		
Opening stock	48 800	
Purchases	108 000	
	156 800	
Closing stock	52 000	
Raw materials consumed		104 800
Direct wages		40 200
Production overhead		60 900
Production cost incurred		205 900
Work in progress:		
Opening stock	64 000	
Closing stock	58 000	6 000
Cost of goods produced		211 900
Sales		440 000
Finishing goods:		
Opening stock	120 000	
Cost of goods produced	211 900	
	331 900	
Closing stock	121 900	
Cost of goods sold		210 000
Gross profit		230 000

From the cost accounts, the following information has been extracted:

Control account balances at 1 January	(£)
Raw material stores	49 500
Work in progress	60 100
Finished goods	115 400

Transactions for the quarter:	(£)
Raw materials issued	104 800
Cost of goods produced	222 500
Cost of goods sold	212 100
Loss of materials damaged by flood (insurance claim pending)	2 400

A notional rent of £4000 *per month* has been charged in the cost accounts. Production overhead was absorbed at the rate of 185% of direct wages.

You are required to:

(a) prepare the following control accounts in the cost ledger:
raw materials stores;
work in process;
finished goods;
production overhead;

(10 marks)

(b) prepare a statement reconciling the gross profits as per the cost accounts and the financial accounts;

(11 marks)

(c) comment on the possible accounting treatment(s) of the under- or over-absorption of production overhead, assuming that the financial year of the company is 1 January to 31 December.

(4 marks)

(Total 25 marks)

CIMA Cost Accounting 1

5.20 Contract costing

HR Construction plc makes up its accounts to 31 March each year. The following details have been extracted in relation to two of its contracts:

	Contract A	Contract B
Commencement date	1 April 1999	1 December 1999
Target completion date	31 May 2000	30 June 2000
Retention %	4	3
	£000	£000
Contract price	2000	550
Materials sent to site	700	150
Materials returned to stores	80	30
Plant sent to site	1000	150
Materials transferred	(40)	40
Materials on site 31 March 2000	75	15
Plant hire charges	200	30
Labour cost incurred	300	270
Central overhead cost	75	18
Direct expenses incurred	25	4
Value certified	1500	500
Cost of work not certified	160	20
Cash received from client	1440	460
Estimated cost of completion	135	110

Depreciation is charged on plant using the straight line method at the rate of 12% per annum.

Required:

(a) Prepare contract accounts, in columnar format, for EACH of the contracts A and B, showing clearly the amounts to be transferred to profit and loss in respect of each contract.

(20 marks)

(b) Show balance sheet extracts in respect of EACH contract for fixed assets, debtors and work in progress.

(4 marks)

(c) Distinguish between job, batch and contract costing. Explain clearly the reasons why these methods are different.

(6 marks)

(Total 30 marks)

CIMA Stage 2 Operational Cost Accounting



Process costing

6

A process costing system is used in those industries where masses of similar products or services are produced. Products are produced in the same manner and consume the same amount of direct costs and overheads. It is therefore unnecessary to assign costs to individual units of output. Instead, the average cost per unit of output is calculated by dividing the total costs assigned to a product or service for a period by the number of units of output for that period. Industries where process costing is widely used include chemical processing, oil refining, food processing and brewing. In contrast, job costing relates to a costing system where each unit or batch of output is unique. This creates the need for the cost of each unit to be calculated separately.

Our objective in this chapter is to examine the cost accumulation procedure that is required for inventory valuation and profit measurement for a process costing system. We shall also discuss briefly at the end of the chapter how cost information should be accumulated and extracted for decision-making and cost control. We begin with a description of the flow of production and costs in a process costing environment. We shall then focus on the cost accumulation system. To provide a structured presentation three different

LEARNING OBJECTIVES

After studying this chapter you should be able to:

- explain when process costing systems are appropriate;
- explain the accounting treatment of normal and abnormal losses;
- prepare process, normal loss, abnormal loss and abnormal gain accounts when there is no ending work in progress;
- explain and calculate equivalent units;
- compute the value of closing work in progress and completed production using the weighted average and first in, first out methods of valuing work in progress;
- distinguish between the different cost per unit calculations that are necessary for inventory valuation, decision-making and performance reporting for cost control.

scenarios will be presented. First, all output is fully complete. Second, ending work in progress exists, but no beginning work in progress, and some of the units started during the period are incomplete at the end of the period. Our third scenario is the existence of both beginning and ending work in progress of uncompleted units. Finally, we shall turn our attention to decision-making and cost control. One of the most complex areas in process costing is accounting for losses when units within the process are both fully and partially complete. Because some courses omit this topic it will be discussed in Appendix 6.1.

Flow of production and costs in a process costing system

The flow of production and costs in a process costing system is illustrated in Exhibit 6.1. The major differences between process and job costing are also highlighted. You will see that production moves from one process (or department) to the next until final completion occurs. Each production department performs some part of the total operation and transfers its completed production to the next department, where it becomes the input for further processing. The completed production of the last department is transferred to the finished goods inventory.

The cost accumulation procedure follows this production flow. Control accounts are established for each process (or department) and direct and indirect costs are assigned to each process. A process costing system is easier to operate than a job costing system because the detailed work of allocating costs to many individual cost units is unnecessary. Also, many of the costs that are indirect in a job costing system may be regarded as direct in a process costing system. For example, supervision and depreciation that is confined to one department would be treated as part of the direct costs of that department in a process costing system, since these costs are directly attributable to the cost object (i.e. the department or process). However, such costs are normally regarded as indirect in a job costing system because they are not directly attributable to a specific job.

As production moves from process to process costs are transferred with it. For example, in Exhibit 6.1 the costs of process A would be transferred to process B; process B costs would then be added to this cost and the resulting total cost transferred to process C; process C costs would then added to this cost. Therefore the cost becomes cumulative as production proceeds and the addition of the costs from the last department's cost determines the total cost. The cost per unit of the completed product thus consists of the total cost accumulated in process C for the period divided by the output for that period.

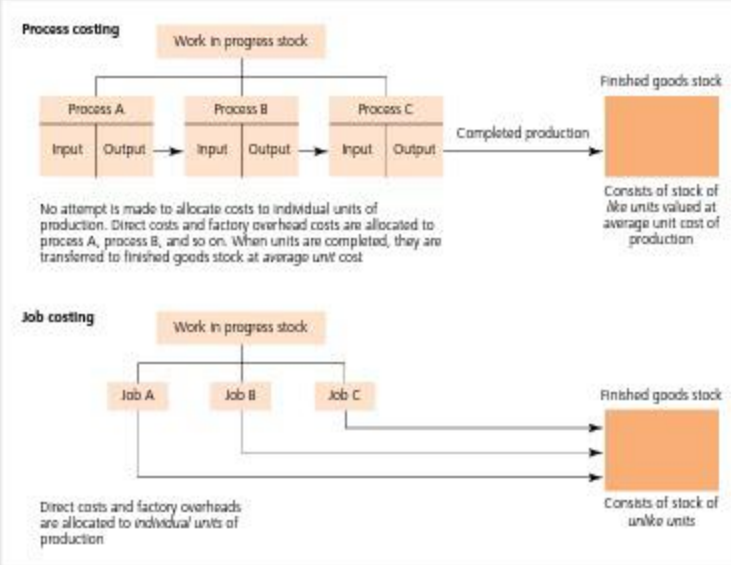
Process costing when all output is fully complete

Throughout this section it is assumed that all output within each process is fully complete. We shall examine the following situations:

1. no losses within a process;
2. normal losses with no scrap value;
3. abnormal losses with no scrap value;
4. normal losses with a scrap value;
5. abnormal losses with a scrap value;
6. abnormal gains with no scrap value;
7. abnormal gains with a scrap value.

EXHIBIT 6.1

A comparison of job and process costing



You should now look at Example 6.1. The information shown in this example will be used to illustrate the accounting entries. To simplify the presentation it is assumed that the product is produced within a single process.

No losses within the process

To calculate the cost per unit (i.e. litre) of output for case 1 in Example 6.1 we merely divide the total cost incurred for the period of £120 000 by the output for the period (12 000 litres). The cost per unit of output is £10. In practice the cost per unit is analysed by the different cost categories such as direct materials and **conversion cost** which consists of the sum of direct labour and overhead costs.

EXAMPLE 6.1

Dartmouth Company produces a liquid fertilizer within a single production process. During the month of May the input into the process was 12 000 litres at a cost of £120 000. There were no opening or closing inventories and all output was fully complete. We shall prepare the process account and calculate the cost per litre of output for the single process for each of the following seven cases:

Case	Input (litres)	Output (litres)	Normal loss (litres)	Abnormal loss (litres)	Abnormal gain (litres)	Scrap value of spoilt output (£ per litre)
1	12 000	12 000	0	0	0	0
2	12 000	10 000	2000 (1/6)	0	0	0
3	12 000	9 000	2000 (1/6)	1 000	0	0
4	12 000	10 000	2000 (1/6)	0	0	5
5	12 000	9 000	2000 (1/6)	1 000	0	5
6	12 000	11 000	2000 (1/6)	0	1 000	0
7	12 000	11 000	2000 (1/6)	0	1 000	5

Normal losses in process with no scrap value

Certain losses are inherent in the production process and cannot be eliminated. For example, liquids may evaporate, part of the cloth required to make a suit may be lost and losses occur in cutting wood to make furniture. These losses occur under efficient operating conditions and are unavoidable. They are referred to as **normal or uncontrollable losses**. Because they are an inherent part of the production process normal losses are absorbed by the good production. Where normal losses apply the cost per unit of output is calculated by dividing the costs incurred for a period by the *expected* output from the actual input for that period. Looking at case 2 in Example 6.1 you will see that the normal loss is one sixth of the input. Therefore for an input of 12 000 litres the *expected* output is 10 000 litres so that the cost per unit of output is £12 (£120 000/10 000 litres). Actual output is equal to expected output so there is neither an abnormal loss nor gain. Compared with case 1 the unit cost has increased by £2 per unit because the cost of the normal loss has been absorbed by the good production. Our objective is to calculate the cost of normal production under normal efficient operating conditions.

Abnormal losses in process with no scrap value

In addition to losses that cannot be avoided, there are some losses that are not expected to occur under efficient operating conditions, for example the improper mixing of ingredients, the use of inferior materials and the incorrect cutting of cloth. These losses are not an inherent part of the production process, and are referred to as **abnormal or controllable losses**. Because they are not an inherent part of the production process and arise from inefficiencies they are not included in the process costs. Instead, they are removed from the appropriate process account and reported separately as an abnormal loss. The abnormal loss is treated as a period cost and

written off in the profit statement at the end of the accounting period. This ensures that abnormal losses are not incorporated in any inventory valuations.

For case 3 in Example 6.1 the expected output is 10 000 litres but the actual output was 9000 litres, resulting in an abnormal loss of 1000 litres. Our objective is the same as that for normal losses. That is to calculate the cost per litre of the *expected* output (i.e. normal production), which is:

$$\frac{\text{input cost (£120 000)}}{\text{expected output (10 000 litres)}} = £12$$

Note that the unit cost is the same for an output of 10 000 or 9000 litres since our objective is to calculate the cost per unit of normal output. The distribution of the input costs is as follows:

	(£)
Completed production transferred to the next process (or finished goods inventory) 9000 litres at £12	108 000
Abnormal loss: 1000 litres at £12	12 000
	120 000

The abnormal loss is valued at the cost per unit of normal production. Abnormal losses can only be controlled in the future by establishing the cause of the abnormal loss and taking appropriate remedial action to ensure that it does not reoccur. The entries in the process account will look like this:

Process account

	Litres	Unit cost (£)	(£)		Litres	Unit cost (£)	(£)
Input cost	12 000	10	120 000	Normal loss	2 000	—	—
				Output to finished goods inventory	9 000	12	108 000
				Abnormal loss	1 000	12	12 000
			120 000				120 000

Process accounts represent work in progress (WIP) accounts. For example, if a second process were required and the 9000 litres had remained from the first process at the end of the accounting period the £108 000 would have represented the work in progress valuation in the process. In our example all of the work in progress has been completed and transferred to the finished goods inventory. Input costs are debited to the process account and the output from the process is entered on the credit side.

You will see from the process account that no entry is made in the account for the normal loss (except for an entry made in the units column). The transfer to the finished goods inventory (or the next process) is at the cost of normal production. The abnormal loss is removed from the process costs and reported separately as a loss in the abnormal loss account. This draws the attention of management to those losses that may be controllable. At the end of the accounting period the abnormal loss account is written off in the profit statement as a period cost. The inventory valuation will not therefore include any abnormal expenses. The overall effect is that the



How process and activity-based cost analysis meets the needs of a small manufacturer

Kunde Estate Winery is a small wine producer in California's Sonoma Valley. Cost accounting for wine making differs in several ways from the system used by other manufacturers. The system is a hybrid between process costing and job costing. As each lot of wine in a given vintage may be processed differently, each *process* can incur varying costs. Process department costs are clearly identified. The key to costing wine inventory is to follow the wine's movements. Equipment and depredation are identified by department where possible. Otherwise, depredation is allocated based on estimated usage by *process* departments, including Crush and Ferment, Tank Aging, Barrel Aging, Bottling and General Production. Each department incurs costs that are periodically allocated. Allocations of process costs need only be applied to individual lots at bottling and at year end. Between applications of process costs to lots, the lot costs will change with blending activity and losses from it.

Labour and benefits are charged to the general production department. Each month, the wine maker and the cellar master review the work performed and report to accounting the percentage of each employee's time spent in each department. These estimates provide the basis of allocation for labour. The general production department is the overhead department for wine making operations. The wine maker's salary and benefits, and insurance, laboratory and administrative expenses, are collected here for allocation to the process departments, based on estimates of activity by the wine maker.



Source: Kunde Estate Winery and Vineyards

Source: Adapted from Lee, J.Y. and Jacobs, B.G., How process and activity-based cost analysis meets the needs of a small manufacturer, *CMA Magazine* (Canada), April 93, Vol. 67 Issue 3, pp. 15–19.

abnormal losses are correctly allocated to the period in which they arise and are not carried forward as a future expense in the closing inventory valuation.

Normal losses in process with a scrap value

In case 4 actual output is equal to the expected output of 10 000 litres so there is neither an abnormal gain nor loss. All of the units lost represent a normal loss in process. However, the units lost now have a scrap value of £5 per litre. The sales value of the spoiled units should be offset against the costs of the appropriate process where the loss occurred. Therefore the sales value of the normal loss is credited to the process account and a corresponding debit entry will be made in the cash or accounts receivable (debtors) account. The calculation of the cost per unit of output is as follows:

$$\frac{\text{Input cost less scrap value of normal loss}}{\text{Expected output}} = \frac{£120\,000 - (2000 \times £5)}{10\,000 \text{ litres}} = £11$$

Compared with cases 2 and 3 the cost per unit has declined from £12 per litre to £11 per litre to reflect the fact that the normal spoilage has a scrap value which has been offset against the process costs.

The entries in the process account will look like this:

Process account

	Litres	Unit cost (£)	(£)		Litres	Unit cost (£)	(£)
Input cost	12 000	10	120 000	Normal loss	2 000	—	10 000
				Output to finished goods inventory	10 000	11	110 000
			120 000				120 000

Note that the scrap value of the normal loss is credited against the normal loss entry in the process account.

Abnormal losses in process with a scrap value

In case 5 expected output is 10 000 litres for an input of 12 000 litres and actual output is 9000 litres resulting in a normal loss of 2000 litres and an abnormal loss of 1000 litres. The lost units have a scrap value of £5 per litre. Since our objective is to calculate the cost per unit for the expected (normal) output only the scrap value of the normal loss of 2000 litres should be deducted in ascertaining the cost per unit. Therefore the cost per unit calculation is the same as that for case 4 (i.e. £11). The sales value of the additional 1000 litres lost represents revenue of an abnormal nature and should not be used to reduce the process unit cost. This revenue is offset against the cost of the abnormal loss which is of interest to management. The net cost incurred in the process is £105 000 (£120 000 input cost less 3000 litres lost with a scrap value of £5 per litre), and the distribution of this cost is:

	(£)	(£)
Completed production transferred to the next process (or finished goods inventory) (9000 litres at £11 per litre)		99 000
Abnormal loss:		
1000 litres at £11 per litre	11 000	
Less scrap value (1000 litres at £5)	5 000	6 000
		105 000

The entries in the process account will be as follows:

Process account

	Litres	Unit cost (£)	(£)		Litres	Unit cost (£)	(£)
Input cost	12 000	10	120 000	Normal loss	2 000	—	10 000
				Output to finished goods inventory	9 000	11	99 000
				Abnormal loss	1 000	11	11 000
			120 000				120 000

Abnormal loss account

	(£)		(£)
Process account	11 000	Cash sale for units scrapped	5 000
		Balance transferred to profit statement	6 000
	11 000		11 000

Abnormal gains with no scrap value

On occasions the actual loss in process may be less than expected, in which case an **abnormal gain** results. In case 6 the expected output is 10 000 litres for an input of 12 000 litres but the actual output is 11 000 litres resulting in an abnormal gain of 1000 litres. We are assuming for this case that the normal loss does not have a scrap value. As in the previous cases our objective is to calculate the cost per unit of expected (normal) output. The calculation of the cost per unit of normal output is the same as that for cases 2 and 3, which is:

$$\frac{\text{input cost (£120 000)}}{\text{expected output (10 000 litres)}} = £12$$

and the distribution of the input cost is as follows:

	(£)
Completed production transferred to the next process (or finished goods inventory) 11 000 litres at £12	132 000
Less: Abnormal gain: 1000 litres at £12	12 000
	120 000

The value of the gain is calculated in the same way as the abnormal loss and removed from the process account by debiting the account and crediting the abnormal gain account. The entries in the process account will be as follows:

Process account

	Litres	Unit cost (£)	(£)		Litres	Unit cost (£)	(£)
Input cost	12 000	10	120 000	Normal loss	2 000	—	—
Abnormal gain	1 000	12	12 000	Output to finished goods inventory	11 000	12	132 000
			132 000				132 000

You will see in the process account that 11 000 litres are passed to the next process at the cost per unit of *normal* output. The gain is credited to the abnormal gain account and transferred to the credit of the profit and loss statement at the end of the period. This procedure ensures that the inventory valuation is not understated by gains of an abnormal nature.

Abnormal gains with a scrap value

The only difference between cases 7 and 6 is that any losses have a scrap value of £5 per litre. As in the previous cases we start by calculating the cost per unit of normal output. For normal output our assumptions are the same as those for cases 4 and 5 (i.e. a normal loss of one sixth and a scrap value of £5 per litre) so the cost per unit of output is the same (i.e. £11 per litre). The calculation is as follows:

$$\frac{\text{Input cost less scrap value of normal loss}}{\text{Expected output}} = \frac{£120\,000 - (2000 \times £5)}{10\,000 \text{ litres}} = £11$$

The net cost incurred in the process is £115 000 (£120 000 input cost less 1000 litres spoilt with a sales value of £5 per litre), and the distribution of this cost is as follows:

		(£)
Transferred to finished goods inventory (11 000 litres at £11 per litre)		121 000
Less abnormal gain (1000 litres at £11 per litre)	11 000	
lost sales of spoiled units (1000 litres at £5 per litre)	5 000	6 000
		115 000

Note that the cost per unit is based on the normal production cost per unit and is not affected by the fact that an abnormal gain occurred or that sales of the spoiled units with a sales value of £5000 did not materialize. Our objective is to produce a cost per unit based on normal operating efficiency.

The accounting entries are as follows:

Process account

	Litres	Unit cost (£)	(£)		Litres	Unit cost (£)	(£)
Input cost	12 000	10	120 000	Normal loss	2 000	—	10 000
Abnormal gain	1 000	11	11 000	Output to finished goods inventory	11 000	11	121 000
			131 000				131 000

Abnormal gain account

	(£)		(£)
Normal loss account	5 000	Process account	11 000
Profit and loss statement (Balance)	6 000		
	11 000		11 000

Income due from normal losses

	(£)		(£)
Process account	10 000	Abnormal gain account	5 000
		Cash from spoiled units (1000 litres at £5)	5 000
	10 000		10 000

You will see that the abnormal gain has been removed from the process account and that it is valued at the cost per unit of normal production. However, as 1000 litres were gained, there was a loss of sales revenue of £5000, and this lost revenue is offset against the abnormal gain. The net gain is therefore £6000, and this is the amount that should be credited to the profit statement.

The process account is credited with the expected sales revenue from the normal loss (2000 litres at £5), since the objective is to record in the process account normal net costs of production. Because the normal loss of 2000 litres does not occur, the company will not obtain the sales value of £10 000 from the expected lost output. This problem is resolved by making a corresponding debit entry in a normal loss account, which represents the amount due from the sale proceeds from the expected normal loss. The amount due (£10 000) is then reduced by £5000 to reflect the fact that only 1000 litres were lost. This is achieved by crediting the normal loss account (income due) and debiting the abnormal gain account with £5000, so that the balance of the normal loss account shows the actual amount of cash received for the income due from the spoiled units (i.e. £5000, which consists of 1000 litres at £5 per litre).

Process costing with ending work in progress partially complete

So far we have assumed that all output within a process is fully complete. We shall now consider situations where output started during a period is partially complete at the end of the period. In other words, ending work in progress exists within a process. When some of the output started during a period is partially complete at the end of the period, unit costs cannot be computed by simply dividing the total costs for a period by the output for that period. For example, if 8000 units were started and completed during a period and another 2000 units were partly completed then these two items cannot be added together to ascertain their unit cost. We must convert the work in progress into finished equivalents (also referred to as **equivalent production**) so that the unit cost can be obtained.

To do this we must estimate the percentage degree of completion of the work in progress and multiply this by the number of units in progress at the end of the accounting period. If the 2000 partly completed units were 50% complete, we could express this as an equivalent production of 1000 fully completed units. This would then be added to the completed production of 8000 units to give a total equivalent production of 9000 units. The cost per unit would then be calculated in the normal way. For example, if the costs for the period were £180 000 then the cost per unit completed would be £20 (£180 000/9000 units) and the distribution of this cost would be as follows:

	(£)
Completed units transferred to the next process (8000 units at £20)	160 000
Work in progress (1000 equivalent units at £20)	20 000
	180 000

Elements of costs with different degrees of completion

A complication that may arise concerning equivalent units is that in any given stock of work in progress not all of the elements that make up the total cost may have reached the same degree of completion. For example, materials may be added at the start of the process, and are thus fully complete, whereas labour and manufacturing overhead

(i.e. the conversion costs) may be added uniformly throughout the process. Hence, the ending work in progress may consist of materials that are 100% complete and conversion costs that are only partially complete. Where this situation arises, separate equivalent production calculations must be made for each element of cost. The calculation of unit costs and the allocation of costs to work in progress and completed production when different elements of costs are subject to different degrees of completion will now be illustrated using the data given in Example 6.2.

The following statement shows the calculation of the cost per unit for process A:

Calculation of cost per unit for process A

Cost element	Total cost (£)	Completed units	WIP equivalent units	Total equivalent units	Cost per unit (£)
Materials	210 000	10 000	4 000	14 000	15.00
Conversion cost	144 000	10 000	2 000	12 000	12.00
	354 000				27.00

	(£)	(£)
Value of work in progress:		
Materials (4000 units at £15)	60 000	
Conversion cost (2000 units at £12)	24 000	84 000
Completed units (10 000) units at £27)		270 000
		354 000

The process account will look like this:

Process A account

Materials	210 000	Completed units transferred to process B	270 000
Conversion cost	144 000	Closing WIP c/fwd	84 000
	354 000		354 000
Opening WIP b/fwd	84 000		

You will see from the above statement that details are collected relating to the equivalent production for completed units and work in progress by materials and conversion costs. This information is required to calculate the cost per unit of equivalent production for each element of cost. The work in progress of 4000 units is considered to be fully complete regarding materials. As materials are issued at the start of the process any partly completed units in ending work in progress must be fully complete as far as materials are concerned. Therefore an entry of 4000 units is made in the work in progress equivalent units column in the above statement for materials. Regarding conversion cost, the 4000 units in progress are only 50% complete and therefore the entry in the work in progress column for this element of cost is 2000 units. To compute the value of work in progress, the unit costs are multiplied separately by the materials and conversion cost work in progress equivalent production figures. Only one calculation is required to ascertain the value of completed production. This is obtained by multiplying the total cost per unit of £27 by the completed production. Note that the cost of the output of £354 000 in the above statement is in agreement with the cost of input of £354 000.

EXAMPLE 6.2

The Fontenbleau Company manufactures a product that passes through two processes. The following information relates to the two processes:

	Process A	Process B
Opening work in progress	—	—
Units introduced into the process	14 000	10 000
Units completed and transferred to the next process or finished goods inventory	10 000	9 000
Closing work in progress	4 000	1 000
Costs of production transferred from process A[a]		£270 000
Material costs added	£210 000	£108 000
Conversion costs	£144 000	£171 000

Materials are added at the start of process A and at the end of process B and conversion costs are added uniformly throughout both processes. The closing work in progress is estimated to be 50% complete for both processes.

Note

[a]This information is derived from the preparation of process A accounts.

Previous process cost

As production moves through processing, the output of one process becomes the input of the next process. The next process will carry out additional conversion work, and may add further materials. It is important to distinguish between these different cost items; this is achieved by labelling the transferred cost from the previous process '**previous process cost**'. Note that this element of cost will always be fully complete as far as closing work in progress is concerned. Let us now calculate the unit costs and the value of work in progress and completed production for process B. To do this we prepare a statement similar to the one we prepared for process A.

Calculation of cost per unit for process B

Cost element	Total cost (£)	Completed units	WIP equivalent units	Total equivalent units	Cost per unit (£)
Previous process cost	270 000	9 000	1000	10 000	27.00
Materials	108 000	9 000	—	9 000	12.00
Conversion cost	171 000	9 000	500	9 500	18.00
	549 000				57.00

	(£)	(£)
Value of work in progress:		
Previous process cost (1000 units at £27)	27 000	
Materials	—	
Conversion cost (500 units at £18)	9 000	36 000
Completed units (9000 units at £57)		513 000
		549 000

Process B account

Previous process cost	270 000	Completed production	
Materials	108 000	transferred to finished stock	513 000
Conversions cost	171 000	Closing work in progress c/fwd	36 000
	549 000		549 000
Opening WIP b/fwd	36 000		

You will see that the previous process cost is treated as a separate process cost, and, since this element of cost will not be added to in process B, the closing work in progress must be fully complete as far as previous process cost is concerned. Note that, after the first process, materials may be issued at different stages of production. In process B materials are not issued until the end of the process, and the closing work in progress will not have reached this point; the equivalent production for the closing work in progress will therefore be zero for materials.

Normally, material costs are introduced at one stage in the process and not uniformly throughout the process. If the work in progress has passed the point at which the materials are added then the materials will be 100% complete. If this point has not been reached then the equivalent production for materials will be zero.

Beginning and ending work in progress of uncompleted units

When opening stocks of work in progress exist, an assumption must be made regarding the allocation of this opening stock to the current accounting period to determine the unit cost for the period. Two alternative assumptions are possible. First, one may assume that opening work in progress is inextricably merged with the units introduced in the current period and can no longer be identified separately – the **weighted average method**. Secondly, one may assume that the opening work in progress is the first group of units to be processed and completed during the current month – the **first in, first out method**. Let us now compare these methods using the information contained in Example 6.3.

For more complex problems it is always a good idea to start by calculating the number of units completed during the period. The calculations are as follows:

	Process X	Process Y
Opening work in progress	6 000	2 000
Units introduced during period	16 000	18 000
Total input for period	22 000	20 000
Less closing work in progress	4 000	8 000
Balance – completed production	18 000	12 000

Weighted average method

The calculation of the unit cost for process X using the weighted average method is as follows:

EXAMPLE 6.3

The Baltic Company has two processes, X and Y. Material is introduced at the start of process X, and additional material is added to process Y when the process is 70% complete. Conversion costs are applied uniformly throughout both processes. The completed units of process X are immediately transferred to process Y, and the completed production of process Y is transferred to finished goods stock. Data for the period include the following:

	Process X	Process Y
Opening work in progress	6000 units 60% converted, consisting of materials £72 000 and conversion cost £45 900	2000 units 80% converted, consisting of previous process cost of £91 800, materials £12 000 and conversion costs £38 400
Units started during the period	16 000 units	18 000 units
Closing work in progress	4000 units 3/4 complete	8000 units 1/2 complete
Material costs added during the period	£192 000	£60 000
Conversion costs added during the period	£225 000	£259 200

Process X – weighted average method

Cost element	Opening WIP (£)	Current cost (£)	Total cost (£)	Completed units	WIP equiv. units	Total equiv. units	Cost per [unit] (£)
Materials	72 000	192 000	264 000	18 000	4000	22 000	12.00
Conversion cost	45 900	225 000	270 900	18 000	3000	21 000	12.90
	117 900		534 900				24.90

	(£)	(£)
Work in progress:		
Materials (4000 units at £12)	48 000	
Conversion (3000 units at £12.90)	38 700	86 700
Completed units (18 000 units at £24.90)		448 200
		534 900

Process X account

Opening work in progress b/fwd	117 900	Completed production transferred to process Y	448 200
Materials	192 000	Closing work in progress c/fwd	86 700
Conversion cost	225 000		
	534 900		534 900
Opening work in progress b/fwd	86 700		

You can see from the statement of unit cost calculations that the opening work in progress is assumed to be completed in the current period. The current period's costs will include the cost of finishing off the opening work in progress, and the cost of the work in progress will be included in the total cost figure. The completed units will include the 6000 units in progress that will have been completed during the period. The statement therefore includes all the costs of the opening work in progress and the resulting units, fully completed. In other words, we have assumed that the opening work in progress is intermingled with the production of the current period to form one homogeneous batch of production. The equivalent number of units for this batch of production is divided into the costs of the current period, plus the value of the opening work in progress, to calculate the cost per unit.

Let us now calculate the unit cost for process Y using the weighted average method. From the calculation of the unit costs you can see the previous process cost is fully complete as far as the closing work in progress is concerned. Note that materials are added when the process is 70% complete, but the closing work in progress is only 50% complete. At the stage in question no materials will have been added to the closing work in progress, and the equivalent production will be zero. As with process X, it is necessary to add the opening work in progress cost to the current cost. The equivalent production of opening work in progress is ignored since this is included as being fully complete in the completed units column. Note also that the completed production cost of process X is included in the current cost column for 'the previous process cost' in the unit cost calculation for process Y.

Process Y – Weighted average method

Cost element	Opening WIP value (£)	Current period cost (£)	Total cost (£)	Completed units	WIP equiv. units	Total equiv. units	Cost per unit (£)
Previous process cost	91 800	448 200	540 000	12 000	8000	20 000	27.00
Materials	12 000	60 000	72 000	12 000	—	12 000	6.00
Conversion cost	38 400	259 200	297 600	12 000	4000	16 000	18.60
	142 200		909 600				51.60

	(£)	(£)
Value of work in progress:		
Previous process cost (8000 units at £27)	216 000	
Materials	—	
Conversion cost (4000 units at £18.60)	74 400	290 400
Completed units (12 000 units at £51.60)		619 200
		909 600

Process Y account

Opening work in progress	142 200	Completed production	
Transferred from process X	448 200	transferred to finished stock	619 200

Materials	60 000	Closing work in progress c/fwd	290 400
Conversion cost	259 200		
	909 600		909 600
Opening work in progress b/fwd	290 400		

First in first out (FIFO) method

The FIFO method of process costing assumes that the opening work in progress is the first group of units to be processed and completed during the current period. The opening work in progress is charged separately to completed production, and the cost per unit is based only on the *current period* costs and production for the current period. The closing work in progress is assumed to come from the new units started during the period. Let us now use Example 6.3 to illustrate the FIFO method for process X and Y.

Process X – FIFO method

Cost element	Current period costs (£)	Completed units less opening WIP equiv. units	Closing WIP equiv. units	Current total equiv. units	Cost per unit (£)
Materials	192 000	12 000 (18 000 – 6000)	4000	16 000	12.00
Conversion cost	225 000	14 400 (18 000 – 3600)	3000	17 400	12.93
	417 000				24.93

	(£)	(£)
Completed production:		
Opening WIP	117 900	
Materials (12 000 units at £12)	144 000	
Conversion cost (14 400 units at £12.93)	186 207	448 107
Closing WIP:		
Materials (4000 units at £12)	48 000	
Conversion cost (3000 units at £12.93)	38 793	86 793
		534 900

From this calculation you can see that the average cost per unit is based on current period costs divided by the current total equivalent units for the period. The latter figure excludes the equivalent production for opening work in progress since this was performed in the previous period. Note that the closing work in progress is multiplied by the current period average cost per unit. The closing work in progress includes only the current costs and does not include any of the opening work in progress, which is carried forward from the previous period. The objective is to ensure that the opening work in progress is kept separate and is identified as part of the cost of the completed production. The opening work in progress of £117 900 is not therefore included in the unit cost calculations, but is added directly to the completed production.

Let us now calculate the units costs for process Y:

Process Y – FIFO method

Cost element	Current costs (£)	Completed units less opening WIP equiv. units	Closing WIP equiv. units	Current total equiv. units	Cost per unit (£)
Previous process cost	448 107	10 000 (12 000 – 2000)	8000	18 000	24.8948
Materials	60 000	10 000 (12 000 – 2000)	—	10 000	6.0
Conversion cost	259 200	10 400 (12 000 – 1600)	4000	14 400	18.0
	767 307				48.8948

	(£)	(£)
Cost of completed production:		
Opening WIP	142 200	
Previous process cost (10 000 units at £24.8948)	248 948	
Materials (10 000 units at £6)	60 000	
Conversion cost (10 400 units at £18)	187 200	638 348
Cost of closing work in progress:		
Previous process cost (8000 units at £24.8948)	199 159	
Materials	—	
Conversion cost (4000 units at £18)	72 000	271 159
		909 507

Note that in this calculation the *opening* work in progress is 80% completed, and that the materials are added when the process is 70% complete. Hence, they will be fully complete. Remember also that previous process cost is always 100% complete. Therefore in the third column of the above statement 2000 units opening work in progress is deducted for these two elements of cost from the 12 000 units of completed production. Conversion cost will be 80% complete so 1600 equivalent units are deducted from the completed production. Our objective in the third column is to extract the equivalent completed units that were derived from the units started during the current period. You should also note that the previous process cost of £448 107 represents the cost of completed production of process X, which has been transferred to process Y.

The closing work in progress valuations and the charges to completed production are fairly similar for both methods. The difference in the calculations between FIFO and the weighted average method is likely to be insignificant where the quantity of inventories and the input prices do not fluctuate significantly from month to month. Both methods are acceptable for product costing, but it appears that the FIFO method is not widely used in practice (Horngren, 1967).

Partially completed output and losses in process

Earlier in this chapter we looked at how to deal with losses in process when all of the output in a process was fully complete. We also need to look at the treatment of losses

when all of the output is not fully complete. When this situation occurs the computations can become complex. Accounting for losses when all of the output is not fully complete does not form part of the curriculum for many courses. However, some professional management accounting courses do require you to have a knowledge of this topic. Because of these different requirements this topic is dealt with in Appendix 6.1. You should therefore check the requirements of your curriculum to ascertain whether you can omit Appendix 6.1.

Process costing for decision-making and control

The detailed calculations that we have made in this chapter are necessary for calculating profit and valuing stocks. For example, the process work in progress forms part of the balance sheet inventory valuations, and the transfers to succeeding processes become part of the work in progress of these processes or form part of the finished goods inventory. If the inventory is sold, these costs become part of the cost of goods sold for profit calculations. The calculations of unit costs, process work in progress valuations and the completed units valuation transferred to the next process are therefore necessary to determine the balance sheet inventory valuation and the cost of goods sold figure.

It is most unlikely that this same information will be appropriate for decision-making and cost control. In particular, process total unit costs will not be relevant for decision-making. What is required is an analysis of costs into their incremental and non-incremental elements for each process. A detailed discussion of those costs that are relevant for decision-making will be deferred to Chapter 10, but it is important that you should note at this point that the costs for decision-making purposes should be assembled in a different way.

Cost control

In respect of cost control, we must ensure that the actual costs that are included on a performance report are the costs incurred for the *current period only* and do not include any costs that have been carried forward from previous periods. This principle can be illustrated using the information given in Example 6.3 for process X.

The unit cost statement for product X, using the weighted average method, shown on page 170 was as follows:

Cost element	Opening WIP value (£)	Current cost (£)	Total cost (£)	Completed units	WIP equiv. units	Total equiv. units	Cost per unit (£)
Materials	72 000	192 000	264 000	18 000	4000	22 000	12.00
Conversion cost	45 900	225 000	270 900	18 000	3000	21 000	12.90

This statement is not appropriate for cost control, since it includes the value of work in progress brought forward from the previous period. Also, the total equivalent units includes the opening work in progress equivalent units partly processed in the

previous period. The inclusion of previous period costs and production is appropriate for inventory valuation and profit measurement, since the objective is to match costs (irrespective of when they were incurred) with revenues, but it is not appropriate to include previous costs for cost control. The objective of cost control is to compare the actual costs of the *current* period with the budgeted cost for the equivalent units produced during the *current* period. We wish to measure a manager's performance for the current period and to avoid this measure being distorted by carrying forward costs that were incurred in the previous period. We must therefore calculate the equivalent units produced during the current period by deducting the equivalent units produced during the previous period from the total number of equivalent units. The calculation is as follows:

	Total equivalent units	Opening WIP equiv. units	Equiv. units produced during period
Materials	22 000	6000	16 000
Conversion cost	21 000	3600 (60% × 6000)	17 400

Note that materials are introduced at the start of the process, and the 6000 units opening work in progress will have been fully completed in the previous period as far as materials are concerned. Assuming that the budgeted costs for the period are £11.40 for materials and £12 for conversion costs we can now present the following cost control performance report:

Performance report

	Budgeted cost (£)	Current period actual cost (£)	Difference (£)
Materials	182 400 (16 000 units at £11.40)	192 000	9 600 adverse
Conversion cost	208 800 (17 400 units at £12)	225 000	16 200 adverse

From this report you will see that we are comparing like with like; that is, both the budgeted costs and the actual costs refer to the equivalent units produced during the *current* period.

Note that information required for cost control must be analysed in far more detail than that presented in the performance report here. For example, the different types of materials and conversion costs must be listed and presented under separate headings for controllable and non-controllable expenses. The essential point to note, however, is that current period actual costs must be compared with the budgeted cost for the current period's production.

Batch/operating costing

It is not always possible to classify cost accumulation systems into job costing and process costing systems. Where manufactured goods have some common characteristics

and also some individual characteristics, the cost accumulation system may be a combination of both the job costing and process costing systems. For example, the production of footwear, clothing and furniture often involves the production of batches, which are variations of a single design and require a sequence of standardized operations. Let us consider a company that makes kitchen units. Each unit may have the same basic frame, and require the same operation, but the remaining operations may differ: some frames may require sinks, others may require to be fitted with work tops; different types of doors may be fitted to each unit, some may be low-quality doors while others may be of a higher quality. The cost of a kitchen unit will therefore consist of the basic frame plus the conversion costs of the appropriate operations. The principles of the cost accumulation system are illustrated in Exhibit 6.2.

The cost of each product consists of the cost of operation 1 plus a combination of the conversion costs for operations 2–5. The cost per unit produced for a particular operation consists of the average unit cost of each batch produced for each operation. It may well be that some products may be subject to a final operation that is unique to the product. The production cost will then consist of the average cost of a combination of operations 1–5 plus the specific cost of the final unique operation. The cost of the final operation will be traced specifically to the product using a job costing system. The final product cost therefore consists of a combination of process costing techniques and job costing techniques. This system of costing is referred to as **operation costing** or **batch costing**.

Surveys of practice

Little information is available on the extent to which process or job costing systems are used in practice. However, surveys of USA (Schwarzbach, 1985), Finnish (Lukka and Granlund, 1996) and Australian (Joye and Blayney, 1990) companies report the following usage rates:

	USA %	Finland %	Australia %
Process costing	36	32	63
Job costing	28	30	40
No process or job costing		38	
Process and Job combined	10		
Operation costing	18		

Presumably the Australian survey adopted a wider definition of process and job costing resulting in the respondents choosing one of the two categories whereas the Finnish study may have adopted a narrower definition. This may account for the fact that 38% of the organizations indicated that they adopted neither purely job nor process costing systems. These companies are likely to combine elements of both job and process costing.

EXHIBIT 6.2
A batch costing system

Product	Operations 1	2	3	4	5	Product cost
A	✓	✓	✓			A = cost of operations 1, 2, 3
B	✓			✓	✓	B = cost of operations 1, 4, 5
C	✓	✓		✓		C = cost of operations 1, 2, 4
D	✓		✓		✓	D = cost of operations 1, 3, 5
E	✓	✓			✓	E = cost of operations 1, 2, 5



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain when process costing systems are appropriate.**

  A process costing system is appropriate in those situations where masses of identical units or batches are produced thus making it unnecessary to assign costs to individual or batches of output. Instead, the average cost per unit or batch of output is calculated by dividing the total costs assigned to a product or service for the period by the number of units or batches of output for that period. Industries using process costing systems include chemicals, textiles and oil refining.

- **Explain the accounting treatment of normal and abnormal losses.**

  Normal losses are inherent in the production process and cannot be eliminated: their cost should be borne by the good production. This is achieved by dividing the costs incurred for a period by the expected output rather than the actual output. Abnormal losses are avoidable, and the cost of these losses should not be assigned to products but recorded separately as an abnormal loss and written off as a period cost in the profit statement. Scrap sales (if any) that result from the losses should be allocated to the appropriate process account (for normal losses) and the abnormal loss account (for abnormal losses).

- **Prepare process, normal loss, abnormal loss and abnormal gain accounts when there is no ending work in progress.**

  The cost accumulation procedure follows the production flow. Control accounts are established for each process (or department) and costs are assigned (debited) to each process. Abnormal losses are credited to the process where they were incurred and debited to an abnormal loss account. Scrap sales arising from normal losses are credited to the process account and any sales of scrap arising from abnormal losses are credited to the abnormal losses account. The accounting entries were illustrated using Example 6.1.

- **Explain and calculate equivalent units.**

  Where stocks of work in progress are in existence, it is necessary in order to create homogeneous units of output to convert the work in progress into finished equivalent units of output. To do this we must estimate the percentage degree of completion of the work in progress and multiply this by the number of units in

progress at the end of the accounting period. For example, if there are 5000 completed units estimated to be 40% complete this represents an equivalent production of 2000 completed units.

- **Compute the value of closing work in progress and completed production using the weighted average method and first in, first out methods of valuing work in progress.**

  There are two alternative methods of allocating opening work in progress costs to production: the weighted average and first in, first out methods. If the weighted average method is used, both the units and the value of opening work in progress are merged with the current period costs and production to calculate the average cost per unit. Using the first in, first out method, the opening work in progress is assumed to be the first group of units to be processed and completed during the current period. The opening work in progress is therefore assigned separately to completed production and the cost per unit is based only on current costs and production for the period. The closing work in progress is assumed to come from the new units that have been started during the period. The computations of closing work in progress and completed production using both methods together with the appropriate accounting entries were illustrated using Example 6.3.

- **Distinguish between the different costs per unit that are necessary for inventory valuation, decision-making and performance reporting for cost control.**

  For inventory valuation an average cost per unit of output is calculated by dividing process costs by the output of the process. Any costs incurred in the previous period (i.e. opening work in progress) and units in progress are merged with current period costs and production to compute the average cost per unit of completed production. The objective is to match the costs incurred with the associated production and this may entail the carrying forward of costs incurred in previous periods. For decision-making the focus is on the additional future costs and revenues resulting from a decision. Therefore only incremental costs (often represented by variable costs) may be relevant for short-term decisions. In respect of cost control, it is only current costs and production that should be included in the performance reports, since the focus should be on a manager's performance for the current period. Thus, performance reports should not be distorted with costs carried forward from previous periods.

- **Additional learning objectives specified in Appendix 6.1.**

  The appendix to this chapter includes one additional objective: to compute the value of normal and abnormal losses when there is ending work in progress. Because accounting for losses when all of the output is not fully complete is a complex topic that does not form part of the curriculum for many courses, this topic is dealt with in Appendix 6.1. You should check your course curriculum to ascertain if you need to read Appendix 6.1.

Appendix 6.1: Losses in process and partially completed units

Normal losses



Earlier in this chapter, we established that normal losses should be considered as part of the cost of the good production. We need to know, however, at what stage in the process the loss occurs so that we can determine whether the whole loss should be allocated to completed production or whether some of the loss should also be allocated to the closing work in progress. If the loss occurs near the end of the process, or is discovered at the point of inspection, only the units which have reached the inspection point should be allocated with the cost of the loss. Alternatively, the loss could be assumed to occur at a specific point, earlier in the process.

Generally, it is assumed that normal losses take place at the stage of completion where inspection occurs. Where such an assumption is made, the normal loss will not be allocated to the closing work in progress, since the loss is related only to units that have reached the inspection point. Consider Example 6A.1.

To calculate the value of the normal loss, we prepare the normal unit cost statement, but with a separate column for the number of units lost:

Element of cost	Total cost (£)	Completed units	Normal loss	WIP equiv. units	Total equiv. units	Cost per unit (£)
Materials	5000	600	100	300	1000	5.0
Conversion cost	3400	600	100	150	850	4.0
	8400					9.0

	(£)	(£)
Value of work in progress:		
Materials (300 units at £5)	1500	
Conversion cost (150 units at £4)	600	2100
Completed units (600 units at £9)	5400	
Normal loss (100 units at £9)	900	6300
		8400 ←

Note here that all of the cost of the normal loss is added to the completed production, since it is detected at the completion stage. The closing work in progress will not have reached this stage, and therefore does not bear any of the loss. The cost per unit completed after the allocation of the normal loss is £10.50 (£6300/600 units).

Some writers suggest that if the equivalent units computation for normal losses is ignored, the cost of the normal loss will be automatically apportioned to the good production. However, the results from adopting this short-cut are not as accurate. The calculations adopting this short-cut approach are as follows:

EXAMPLE 6A.1

A department with no opening work in progress introduces 1000 units into the process; 600 are completed, 300 are half-completed and 100 units are lost (all normal). *Losses are detected upon completion.* Material costs are £5000 (all introduced at the start of the process) and conversion costs are £3400.

	Total cost (£)	Completed units	WIP equiv. units	Total equiv. units	Cost per unit (£)	WIP (£)
Materials	5000	600	300	900	5.5555	1666.65
Conversion cost	3400	600	150	750	4.5333	680.00
					10.0888	2346.65
				Completed units (600 × £10.0888)		6053.35
						8400.00

You can see that ignoring equivalent units for the normal loss decreased equivalent units and thus increases the cost per unit. The values of work in progress and completed production using each approach are as follows:

	Normal loss charged to good production (£)	Short-cut method (£)	Difference (£)
Work in progress	2100	2347	+247
Completed units	6300	6053	−247

If the short-cut approach is used, the work in progress valuation includes £247 normal loss that is not attributable to these units because they have not reached the inspection point. The £247 should be charged only to completed units that have reached the inspection point. It is therefore recommended that the cost of the normal loss is calculated and charged only to those units that have reached the inspection point.

Let us now assume for Example 6A.1 that the loss is detected when the process has reached the 50% stage of completion. The revised cost per unit will be as follows:

Element of cost	Total cost (£)	Completed units	Normal loss	WIP equiv. units	Total equiv. units	Cost per unit
Materials	5000	600	100	300	1000	5.00
Conversion cost	3400	600	50	150	800	4.25
	8400					9.25

The 100 lost units will not be processed any further once the loss is detected at the 50% completion stage. Therefore 50 units equivalent production (100 units × 50%) is entered in the normal loss column for conversion cost equivalent production. Note that materials are introduced at the start of the process and are fully complete when the loss is detected. The cost of the normal loss is

	£
Materials (100 × £5)	500.00
Conversion cost (50 × £4.25)	212.50
	712.50

When losses are assumed to occur at a specific point in the production process, you should allocate the normal loss over all units that have reached this point. In our example the loss is detected at the 50% stage of completion, and the work in progress has reached this point. Therefore the loss should be allocated between completed production and work in progress. If the losses were detected at the 60% stage, all of the normal loss would be allocated to completed production. Alternatively, if losses were detected before the 50% stage, the normal loss would be allocated to completed production and work in progress.

The question is: how should we allocate the normal loss between completed production and work in progress? Several different approaches are advocated, but the most common approach is to apportion the normal loss in the ratio of completed units and WIP equivalent units as follows:

Completed units	(£)	WIP	(£)
Materials 600/900 × £500	333.33	300/900 × £500	166.67
Conversion cost 600/750 × £212.50	170.00	150/750 × £212.50	42.50
	503.33		209.17

The cost of completed units and WIP is:

	(£)	(£)
Completed units:		
(600 × £9.25)	5550.00	
Share of normal loss	503.33	6053.33
WIP:		
Materials (300 × £5)	1500.00	
Conversion cost (150 × £4.25)	637.50	
Share of normal loss	209.17	2346.67
		8400.00

When the lost units have a scrap value the sales value should be deducted from the normal loss and the net cost apportioned between WIP and completed units.

You should note that where the normal loss is to be apportioned between completed production and WIP an alternative and simpler approach is to use the short-cut method described earlier, whereby the normal loss is not included in the unit cost statement. Using the short-cut method calculation (see page 180) you will see that the allocation of costs to completed units and WIP are identical (apart from small rounding differences) to the above calculation.

Abnormal losses

Where abnormal losses are incurred, the correct procedure is to produce the normal unit cost statement, but with the addition of two separate columns for the units lost; one for normal losses and one for abnormal losses. Consider Example 6A.2.

EXAMPLE 6A.2

A department with no opening work in progress introduced 1000 units into the process; 600 are completed, 250 are 20% complete, and 150 units are lost consisting of 100 units of normal loss and 50 units of abnormal loss. Losses are detected *upon completion*. Material costs are £8000 (all introduced at the start of the process) and conversion costs are £4000.

The unit cost calculations are as follows:

Element of cost	Total cost (£)	Completed units	Normal loss	Abnormal loss	WIP equiv. units	Total equiv. units	Cost per unit (£)
Materials	8 000	600	100	50	250	1000	8
Conversion cost	4 000	600	100	50	50	800	5
	12 000						13

	(£)	(£)
Value of work in progress:		
Materials (250 units at £8)	2000	
Conversion cost (50 units at £5)	250	2 250
Completed units (600 units at £13)	7800	
Add normal loss (100 units at £13)	1300	9 100
Abnormal loss (50 units at £13)		650
		12 000

You can see that the normal loss has been charged to completed units only. The abnormal loss is charged to a separate account and written off as a period cost to the profit and loss account. The entries in the process account will be as follows:

Process account

Materials	8 000	Transfer to next process	9 100
Conversion cost	4 000	Abnormal loss written off to profit and loss account	650
		Closing work in progress c/fwd	2 250
	12 000		12 000

Note that there is an argument for allocating the normal loss of £1300 between the completed units and the abnormal loss. If the normal loss is of a significant value then there are strong arguments for doing this, since the normal loss is part of the cost of production. The abnormal loss should therefore be valued at the cost per unit of *normal output*. In the unit cost statement for Example 6A.2 you will see that the completed production is 600 units and the abnormal loss is 50 units. The normal loss of £1300 is therefore apportioned pro rata to completed production and the abnormal loss. The calculations are as follows:

$$\text{completed units } (600/650 \times £1300) = 1200$$
$$\text{abnormal loss } (50/650 \times £1300) = 100$$

The revised value for completed production would then be £9000 (£7800 + £1200), while for the abnormal loss the value would be £750 (£650 + £100). For most examination questions it is unlikely that you will be expected to allocate the normal loss between completed units and the abnormal loss.



Key terms and concepts

abnormal gain (p. 164)
abnormal or controllable losses (p. 160)
batch costing (p. 176)
conversion cost (p. 159)
equivalent production (p. 166)
first in, first out method (p. 169)
normal or uncontrollable losses (p. 160)
operation costing (p. 176)
previous process cost (p. 168)
weighted average method (p. 169)

Key examination points

Process costing questions require many calculations and there is a possibility that you will make calculation errors. Make sure that your answer is clearly presented so that the examiner can ascertain whether or not you are using correct methods to calculate the cost per unit. Questions can generally be classified by three categories. First, all output is fully complete and the problem of equivalent production does not arise (see Review problems 6.12 and 6.13). Second, work in progress (WIP) output is partially complete and there are no losses in process (see Review problem 6.28). Third losses in process apply when WIP is partially complete (see Review problems 6.27, 6.29 and 6.30). Sometimes examination questions do not indicate the stage in the process that losses occur. In this situation you are recommended to assume that the loss occurs at the end of the process and allocate the normal loss to completed production. Do not forget to state this assumption in your answer. The short-cut method should not be used if the loss occurs at the end of the process because this method assumes that the loss is to be shared between WIP and completed units.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

6.1 Describe the differences between process costing and job costing. (*pp. 157–58*)

6.2 Provide examples of industries that use process costing. (*p. 157*)

6.3 Why is cost accumulation easier with a process costing system compared with a job costing system? (*p. 158*)

6.4 Distinguish between normal and abnormal losses and explain how their accounting treatment differs. (*pp. 160–61*)

6.5 What are equivalent units? Why are they needed with a process costing system? (*p. 166*)

6.6 Why is it necessarily to treat 'previous process cost' as a separate element of cost in a process costing system? (*pp. 168–9*)

6.7 How is the equivalent unit cost calculation affected when materials are added at the beginning or at a later stage of the process rather than uniformly throughout the process? (*p. 169*)

6.8 Describe how the weighted average and FIFO methods differ in assigning costs to units completed and closing work in progress. (*pp. 171–2*)

6.9 Under what conditions will the weighted average and FIFO methods give similar results? (*p. 173*)

6.10 When a process costing system is used, explain how cost information requirements differ for inventory valuation/profit measurement, decision-making and performance reporting for cost control. (*pp. 174–75*)

6.11 Explain the distinguishing features of a batch/operating costing system. (*p. 175–6*)

Review problems

6.12 A company uses process costing to value output. During the last month the following information was recorded:

Output:	2800 kg valued at £7.50/kg
Normal loss:	300 kg which has a scrap value of £3/kg
Actual loss:	200 kg

What was the value of the input?

A £22 650
B £21 900
C £21 600
D £21 150

6.13 A company uses process costing to value its output and all materials are input at the start of the process. The following information relates to the process for one month:

Input	3000 units
Opening stock	400 units
Losses	10% of input is expected to be lost
Closing stock	200 units

How many good units were output from the process if actual losses were 400 units?

A 2800 units
B 2900 units
C 3000 units
D 3200 units

6.14 A company uses process costing to value its output. The following was recorded for the period:

Input materials	2000 units at £4.50 per unit
Conversion costs	£13 340
Normal loss	5% of input valued at £3 per unit
Actual loss	150 units

There were no opening or closing stocks.

What was the valuation of one unit of output to one decimal place?

A £11.8
B £11.6
C £11.2
D £11.0

6.15 Which of the following best describes the term 'equivalent units' when using the FIFO method?

A The number of units worked on during a period including the opening and closing stock units.
B The number of whole units worked on during a period ignoring the levels on completion of opening and closing stock units.
C The number of effective whole units worked on during a period allowing for the levels of completion of opening and closing stock units.
D The total number of whole units started during a period ignoring the opening stock units as these were started in the previous period.

6.16 A company uses process costing to establish the cost per unit of its output.

The following information was available for the last month:

Input units	10 000
Output units	9850
Opening stock	300 units, 100% complete for materials and 70% complete for conversion costs
Closing stock	450 units, 100% complete for materials and 30% complete for conversion costs

The company uses the weighted average method of valuing stock.

What were the equivalent units for conversion costs?

A 9505 units
B 9715 units
C 9775 units
D 9985 units

6.17 AK Chemicals produces high-quality plastic sheeting in a continuous manufacturing operation. All materials are input at the beginning of the process. Conversion costs are incurred evenly throughout the process. A quality control inspection occurs 75% through the manufacturing process, when some units are separated out as inferior quality. The following data are available for December.

Materials costs	£90 000
Conversion costs	£70 200
Units started	40 000
Units completed	36 000

There is no opening or closing work in progress. Past experience indicates that approximately 7.5% of the units started are found to be defective on inspection by quality control.

What is the cost of abnormal loss for December?

A £3 600
B £4 050
C £4 680
D £10 800

ACCA Paper 3

6.18 KL Processing Limited has identified that an abnormal gain of 160 litres occurred in its refining process last week. Normal losses are expected and have a scrap value of £2.00 per litre. All losses are 100% complete as to material cost and 75% complete as to conversion costs.

The company uses the weighted average method of valuation and last week's output was valued using the following costs per equivalent unit:

Materials	£9.40
Conversion costs	£11.20

The effect on the profit and loss account of last week's abnormal gain is

A Debit £2528
B Debit £2828
C Credit £2528
D Credit £2848
E Credit £3168

CIMA Stage 2

6.19 The following details relate to the main process of W Limited, a chemical manufacturer:

Opening work in progress	2000 litres, fully complete as to materials and 40% complete as to conversion
Material input	24 000 litres
Normal loss is 10% of input	
Output to process 2	19 500 litres
Closing work in progress	3000 litres, fully complete as to materials and 45% complete as to conversion

The number of equivalent units to be included in W Limited's calculation of the cost per equivalent unit using a FIFO basis of valuation are:

	Materials	Conversion
A	19 400	18 950
B	20 500	20 050
C	21 600	21 150
D	23 600	20 750
E	23 600	21 950

CIMA Stage 2

6.20 Process B had no opening stock. 13 500 units of raw material were transferred in at £4.50 per unit. Additional material at £1.25 per unit was added in process. Labour and overheads were £6.25 per completed unit and £2.50 per unit incomplete.

If 11 750 completed units were transferred out, what was the closing stock in process B?

A £77 625.00
B £14 437.50
C £141 000.00
D £21 000.00

CIMA Stage 1

6.21 A chemical process has a normal wastage of 10% of input. In a period, 2500 kgs of material were input and there was an abnormal loss of 75 kgs.

What quantity of good production was achieved?

A 2175 kg
B 2250 kg
C 2325 kg
D 2475 kg

CIMA Stage 1 Cost Accounting

6.22 KL Processing operates the FIFO method of accounting for opening work in process in its mixing process. The following data relates to April:

Opening work in process	1 000 litres valued at	£1 500
Input	30 000 litres costing	£15 000
Conversion costs		£10 000
Output	24 000 litres	
Closing work in process	3 500 litres	

Losses in processes are expected to be 10% of period input. They are complete as to input material costs but are discovered after 60% conversion. Losses have a scrap value of £0.20 per litre.

Opening work in process was 100% complete as to input materials, and 70% complete as to conversion. Closing work in process is complete as to input materials and 80% complete as to conversion.

A The number of material-equivalent units was
(i) 26 300 litres
(ii) 26 600 litres
(iii) 27 000 litres
(iv) 28 000 litres
(v) 29 000 litres

B The number of conversion-equivalent units was
(i) 26 400 litres
(ii) 26 600 litres
(iii) 26 800 litres
(iv) 27 000 litres
(v) 27 400 litres

(Total 20 marks)
CIMA Stage 1 Operational Cost Accounting

6.23 The following details relate to the main process of Z Limited, a paint manufacturer:

Opening work in process	2 400 litres	fully complete as to materials and 30% complete as to conversion
Material input	58 000 litres	
Normal loss is 5% of input		
Output to next process	52 500 litres	
Closing work in process	3 000 litres	fully complete as to materials and 50% complete as to conversion

All losses occur at the end of the process.

The numbers of equivalent units to be included in Z Limited's calculation of the cost per equivalent unit, using a *weighted average basis* of valuation, are

	Materials	Conversion
A	53 100	51 600
B	55 500	54 000
C	55 500	53 300
D	57 500	56 000
E	57 500	55 300

CIMA Stage 2 – Operational Cost Accounting

6.24 The following information is required for sub-questions (a) to (c)

The incomplete process account relating to period 4 for a company which manufactures paper is shown below:

Process account

	Units	$		Units	$
Material	4000	16 000	Finished goods	2750	
Labour		8 125	Normal loss	400	700
Production overhead		3 498	Work in progress	700	

There was no opening work in process (WIP). Closing WIP, consisting of 700 units, was complete as shown:

Material	100%
Labour	50%
Production overhead	40%

Losses are recognised at the end of the production process and are sold for $1.75 per unit.

(a) Given the outcome of the process, which ONE of the following accounting entries is needed to complete the double entry to the process account?

	Debit	Credit
A	Abnormal Loss account	Process account
B	Process account	Abnormal Loss account
C	Abnormal Gain account	Process account
D	Process account	Abnormal Gain account

(b) The value of the closing WIP was

A $3868 B $4158 C $4678 D $5288

(c) The total value of the units transferred to finished goods was

A $21 052.50 B $21 587.50 C $22 122.50 D $22 656.50

CIMA – Management Accounting Fundamentals

6.25 The following process account has been drawn up for the last month:

Process account

	Units	£		Units	£
Opening WP	250	3 000	Normal loss	225	450
Input:			Output	4100	
Materials	4500	22 500	Abnormal Loss	275	
Labour		37 500	Closing WIP	150	
	4750			4750	

Work in progress has the following level of completion:

	Material	Labour
Opening WIP	100%	40%
Closing WIP	100%	30%

The company uses the FIFO method for valuing the output from the process and all losses occurred at the end of the process.

What were the equivalent units for labour?

A 4380 units
B 4270 units
C 4320 units
D 4420 units.

ACCA Paper 1.2 – Financial Information for Management

6.26 Perth operates a process costing system. The process is expected to lose 25% of input and this can be sold for £8 per kg.

Input for the month were:
Direct materials 3500 kg at a total cost of £52 500
Direct labour £9625 for the period

There is no opening or closing work in progress in the period. Actual output was 2800 kg.

What is the valuation of the output?

A £44 100
B £49 700
C £58 800
D £56 525.

ACCA Paper 1.2 – Financial Information for Management

6.27 **Losses in process (weighted average)**

A company operates expensive process plant to produce a single product from one process. At the beginning of October, 3400 completed units were still in the processing plant, awaiting transfer to finished stock. They were valued as follows:

	(£)
Direct material	25 500
Direct wages	10 200
Production overhead	20 400 (200% of direct wages)

During October, 37 000 further units were put into process and the following costs charged to the process:

	(£)
Direct materials	276 340
Direct wages	112 000
Production overhead	224 000

36 000 units were transferred to finished stock and 3200 units remained in work-in-progress at the end of October which were complete as to material and half-complete as to labour and production overhead. A loss of 1200 units, being normal, occurred during the process.

The average method of pricing is used.

You are required to

(a) prepare for the month of October, a statement (or statements) showing
  (i) production cost per unit in total and by element of cost;
  (ii) the total cost of production transferred to finished stock;
  (iii) the valuation of closing work-in-progress in total and by element of cost;
  (15 marks)

(b) describe five of the characteristics which distinguish process costing from job costing.
  (10 marks)

(Total 25 marks)
CIMA Stage 2 Cost Accounting

6.28 Equivalent production with no losses (FIFO Method)

A company operates a manufacturing process where six people work as a team and are paid a weekly group bonus based upon the actual output of the team compared with output expected.

A basic 37 hour week is worked during which the expected output from the process is 4000 equivalent units of product. Basic pay is £5.00 per hour and the bonus for the group, shared equally, is £0.80 per unit in excess of expected output.

In the week just ended, basic hours were worked on the process. The following additional information is provided for the week:

Opening work in process (1000 units):
  Materials £540 (100% complete)
  Labour and overheads £355 (50% complete).
During the week:
  Materials used £2255
  Overheads incurred £1748
  Completed production 3800 units
Closing work in process (1300 units)
  Materials (100% complete)
  Labour and overheads (75% complete).

There are no process losses.

The FIFO method is used to apportion costs.

Required:

(a) Prepare the process account for the week just ended.

(10 marks)

(b) Explain the purpose of the following documents which are used in the control of, and accounting for, the materials used in the process described in part (a)

(i) purchase requisition

(ii) materials (stores) requisition.

(4 marks)

(14 marks)

ACCA Foundation Stage Paper 3

6.29 Equivalent production with losses (FIFO method)

Adam, the management accountant of Mark Limited, has on file the costs per equivalent unit for the company's process for the last month but the input costs and quantities appear to have been mislaid.

Information that is available to Adam for last month is as follows:

Opening work in progress	100 units, 30% complete
Closing work in progress	200 units, 40% complete
Normal loss	10% of input valued at £2 per unit
Output	1250 units

The losses were as expected and Adam has a record of there being 150 units scrapped during the month. All materials are input at the start of the process. The cost per equivalent unit for materials was £2.60 and for conversion costs was £1.50.

Mark Limited uses the FIFO method of stock valuation in its process account.

Required:

(a) Calculate the units input into the process.

(2 marks)

(b) Calculate the equivalent units for materials and conversion costs.

(4 marks)

(c) Using your answer from (b) calculate the input costs.

(4 marks)

(10 marks)

6.30 Equivalent production and losses in process

A concentrated liquid fertilizer is manufactured by passing chemicals through two consecutive processes. Stores record cards for the chemical ingredients used exclusively by the first process show the following data for May 2000:

Opening stock	4 000 litres	£10 800
Closing stock	8 000 litres	£24 200
Receipts into store	20 000 litres	£61 000

Other process data for May is tabulated below:

	Process 1	Process 2
Direct labour	£4880	£6000
Direct expenses	£4270	—
Overhead absorption rates	250% of direct labour	100% of direct labour
Output	8000 litres	7500 litres
Opening stock of work in process	—	—
Closing stock of work in process	5600 litres	—
Normal yield	85% of input	90% of input
Scrap value of loss	—	—

In process 1 the closing stock of work in process has just passed through inspection, which is at the stage where materials and conversion costs are 100% and 75% completed respectively.

In process 2 inspection is the final operation.

Required:

(a) Prepare the relevant accounts to show the results of the processes for May 2000 and present a detailed working paper showing your calculations and any assumptions in arriving at the data shown in those accounts.

(18 marks)

(b) If supplies of the required chemicals are severely restricted and all production can be sold immediately, briefly explain how you would calculate the total loss to the company if, at the beginning of June, 100 litres of the correct mix of chemicals were spilt on issue to process 1.

(4 marks)

(Total 22 marks)

ACCA Foundation Costing



Joint and by-product costing

7

A distinguishing feature of the production of joint and by-products is that the products are not identifiable as different products until a specific point in the production process is reached. Before this point joint costs are incurred on the production of all products emerging from the joint production process. It is therefore not possible to trace joint costs to individual products.

To meet internal and external profit measurement and inventory valuation requirements, it is necessary to assign all product-related costs (including joint costs) to products so that costs can be allocated to inventories and cost of goods sold. The assignment of joint costs, however, is of little use for decision-making. We shall begin by distinguishing between joint and by-products. This will be followed by an examination of the different methods that can be used to allocate joint costs to products for inventory valuation. We shall then go on to discuss which costs are relevant for decision-making.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- distinguish between joint products and by-products;
- explain and identify the split-off point in a joint-cost situation;
- explain the alternative methods of allocating joint costs to products;
- discuss the arguments for and against each of the methods of allocating joint costs to products;
- present relevant financial information for a decision as to whether a product should be sold at a particular stage or further processed;
- describe the accounting treatment of by-products.

Distinguishing between joint products and by-products

Joint products and by-products arise in situations where the production of one product makes inevitable the production of other products. When a group of individual products is simultaneously produced, and each product has a significant relative sales value, the outputs are usually called **joint products**. Those products that are part of the simultaneous production process and have a minor sales value when compared with the joint products are called **by-products**.

As their name implies, by-products are those products that result incidentally from the main joint products. By-products may have a considerable absolute value, but the crucial classification test is that the sales value is small when compared with the values of the joint products. Joint products are crucial to the commercial viability of an organization, whereas by-products are incidental. In other words, by-products do not usually influence the decision as to whether or not to produce the main product, and they normally have little effect on the prices set for the main (joint) products. Examples of industries that produce both joint and by-products include chemicals, oil refining, mining, flour milling and gas manufacturing.

A distinguishing feature of the production of joint and by-products, is that the products are not identifiable as different individual products until a specific point in the production process is reached, known as the **split-off point**. All products may separate at one time, or different products may emerge at intervals. Before the split-off point, costs cannot be traced to particular products. For example, it is not possible to determine what part of the cost of processing a barrel of crude oil should be allocated to petrol, kerosene or paraffin. After the split-off point, joint products may be sold or subjected to further processing. If the latter is the case, any **further processing costs** can easily be traced to the specific products involved.

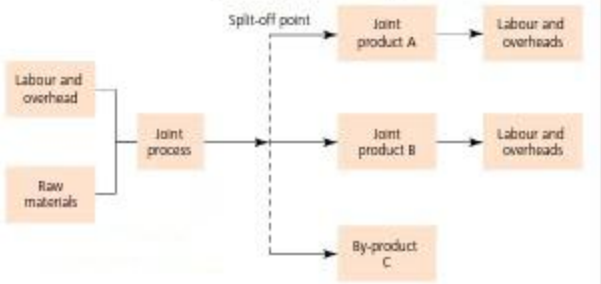
Figure 7.1 illustrates a simplified production process for joint and by-products. You will notice from this illustration that, at the split-off point, joint products A and B and by-product C all emerge, and that it is not possible to allocate costs of the joint process directly to the joint products or by-products. After the split-off point, further processing costs are added to the joint products before sale, and these costs can be specifically attributed to the joint products. By-product C in this instance is sold at the split-off point without further processing, although sometimes by-products may be further processed after the split-off point before they are sold on the outside market.

Methods of allocating joint costs

If all the production for a particular period was sold, the problem of allocating joint costs to products would not exist. Inventory valuations would not be necessary, and the calculation of profit would merely require the deduction of total cost from total sales. However, if inventories are in existence at the end of the period, cost allocation to products are necessary. As any such allocations are bound to be subjective and arbitrary, this area will involve the accountant in making decisions which are among the most difficult to defend. All one can do is to attempt to choose an allocation method that seems to provide a rational and reasonable method of cost distribution. The most frequently used methods that are used to allocate joint costs up to split-off point can be divided into the following two categories:

1. Methods based on physical measures such as weight, volume, etc.
2. Methods assumed to measure the ability to absorb joint costs based on allocating joint costs relative to the market values of the products.

FIGURE 7.1 *Production process for joint and by-products*



We shall now look at four methods that are used for allocating joint costs using the information given in Example 7.1. In Example 7.1 products X, Y and Z all become finished products at the split-off point. The problem arises as to how much of the £600 000 joint costs should be allocated to each individual product? The £600 000 cannot be specifically identified with any of the individual products, since the products themselves were not separated before the split-off point, but some method must be used to split the £600 000 among the three products so that inventories can be valued and the profit for the period calculated. The first method we shall look at is called the **physical measures method**.

Physical measures method

Using this method, the cost allocation is a simple allocation of joint costs in proportion to volume. Each product is assumed to receive similar benefits from the joint cost, and is therefore charged with its proportionate share of the total cost. The cost allocations using this method are as follows:

Product	Units produced	Proportion to total	Joint costs allocated (£)	Cost per unit (£)
X	40 000	1/3	200 000	5
Y	20 000	1/6	100 000	5
Z	60 000	1/2	300 000	5
	120 000		600 000	

Note that this method assumes that the cost per unit is the same for each of the products. Therefore an alternative method of allocating joint costs is as follows:

$$\text{cost per unit} = £5\ (£600\,000/120\,000)$$

EXAMPLE 7.1

During the month of July the Van Nostrand Company processes a basic raw material through a manufacturing process that yields three products – products X, Y and Z. There were no opening inventories and the products are sold at the split-off point without further processing. We shall initially assume that all of the output is sold during the period. Details of the production process and the sales revenues are given in the following diagram.



Thus the joint cost allocations are:

Product X: 40 000 × £5 = £200 000
Product Y: 20 000 × £5 = £100 000
Product Z: 60 000 × £5 = £300 000

Where market prices of the joint products differ, the assumptions of identical costs per unit for each joint product will result in some products showing high profits while others may show losses. This can give misleading profit calculations. Let us look at the product profit calculations using the information given in Example 7.1.

Product	Sales revenue (£)	Total cost (£)	Profit (loss) (£)	Profit/sales (%)
X	300 000	200 000	100 000	33⅓
Y	500 000	100 000	400 000	80
Z	200 000	300 000	(100 000)	(50)
	1 000 000	600 000	400 000	40

You will see from these figures that the allocation of the joint costs bears no relationship to the revenue-producing power of the individual products. Product Z is allocated with the largest share of the joint costs but has the lowest total sales revenue; product Y is allocated with the lowest share of the joint costs but has the highest total sales revenue. The physical measures method is not therefore very satisfactory, and its weakness can be further highlighted if we assume that 80% of the production X, Y and Z were sold during the period. The appropriate inventory valuations and corresponding sales value of each product would be as follows:

Product	Inventory valuations cost[a] (£)	Sales values[a] (£)
X	40 000	60 000
Y	20 000	100 000
Z	60 000	40 000
	120 000	200 000

[a]20% of total cost and sales revenue.

It appears inappropriate to value the stock of product Z at a price higher than its market value and at a valuation three times higher than that of product Y, when in fact product Y is more valuable in terms of potential sales revenue. A further problem is that the joint products must be measurable by the same unit of measurement. Difficult measurement problems arise in respect of products emerging from the joint process consisting of solids, liquids and gases, and it is necessary to find some common base. For example, in the case of coke, allocations can be made on the basis of theoretical yields extracted from a ton of coke.

The main advantage of using the physical measures method is simplicity, but this is outweighed by its many disadvantages.

Sales value at split-off point method

When the **sales value at split-off point method** is used, joint costs are allocated to joint products in proportion to the estimated sales value of production on the assumption that higher selling prices indicate higher costs. To a certain extent, this method could better be described as a means of apportioning profits or losses, according to sales value, rather than a method for allocating costs. Using the information in Example 7.1, the allocations under the sales value method would be as follows:

Product	Units produced	Sales value (£)	Proportion of sales value to total (%)	Joint costs allocated (£)
X	40 000	300 000	30	180 000
Y	20 000	500 000	50	300 000
Z	60 000	200 000	20	120 000
		1 000 000		600 000

The revised product profit calculations would be as follows:

Product	Sales revenue (£)	Total cost (£)	Profit (loss) (£)	Profit/sales (%)
X	300 000	180 000	120 000	40
Y	500 000	300 000	200 000	40
Z	200 000	120 000	80 000	40
	1 000 000	600 000	400 000	



Joint product costing in the semiconductor industry

In the semiconductor industry, the production of memory chips may be viewed as a joint processing situation because the output consists of different quality chips from a common production run. The manufacturing operation is composed of three phases: fabrication, assembly, and a 'stress test'. The first and second steps are mandatory. The third is optional and necessary to produce memory with a longer life expectancy. Of the three cases, only fabrication represents a joint production process; assembly and stress testing are separable steps.

The input to the fabrication phase is raw silicon wafers, which are first photolithographed and then baked at high temperatures. Each wafer will yield multiple chips of identical design. Upon completion of the fabrication process, the finished wafer is tested to identify usable and unusable chips. The test also classifies usable chips according to density (the number of good memory bits) and speed (the time required to access those bits).

The input to the assembly process is usable chips, which are encapsulated in ceramic and wired for use on a memory board. The encapsulation process varies according to the number of chips, which constitute a finished module. Modules of a given density may be composed of one all-good chip or multiple partially good chips. The finished modules are subjected to a nondestructive functional test to identify defective output.

If an extended life expectancy is not required, the good modules are not processed any further. A small sample of the good modules is subjected to the destructive reliability test before the finished product is considered salable. This destructive reliability test is a traditional quality control step designed to establish the 'time-to-failure' distribution of the output. The profile of this distribution will depend, in part, upon whether the modules were subjected to the optional stress test.



Source: Corbis

If a longer life expectancy is desired, the modules are stressed before being tested for reliability. This optional step exposes the modules to extreme conditions and those that survive are labelled extended-life modules. The proportion of the modules selected to undergo the stress test is under management control and can be varied with market conditions.

The final output of the process differs in quality according to a variety of dimensions. These include number of chips per module, speed, life expectancy, and temperature tolerance.

Source: Adapted from Cats-Baril, W.L. *et al.*, (1986) Joint product costing in the semiconductor industry, *Management Accounting (USA)*, pp. 28–35.

If we assume that 80% of the production is sold, the stock valuations would be as follows:

	Inventory valuations	
Product	Cost[a]	Sales values[a]
X	36 000	60 000
Y	60 000	100 000
Z	24 000	40 000
	120 000	200 000

[a]20% of total cost and sales revenue.

The sales value method ensures that the inventory valuation does not exceed the net realizable value, but can itself be criticized since it is based on the assumption that sales revenue determines prior costs. For example, an unprofitable product with low sales revenue will be allocated with a small share of joint cost, thus giving the impression that it is generating profits.

In our discussion so far, relating to inventory valuations, we have assumed that inventories represented 20% of total production for each product. Therefore the total inventory valuation was £120 000 for both the physical measures and sales value at split-off methods of allocating joint costs. However, significant differences in the allocation of joint costs to inventories and cost of sales can occur between the two allocation methods. Consider a situation where the proportions of output for each product shown in Example 7.1 is as follows:

	Proportion of joint output sold (%)	Proportion of joint output included in the closing inventory (%)
Product X	90	10
Product Y	70	30
Product Z	90	10

Using the joint-cost allocations that we have already computed the allocations to inventories and cost of goods sold are as follows:

	Physical measures method			Sales value at split-off point method		
	Total joint costs allocated (£)	Allocated to inventories (£)	Allocated to cost of goods sold (£)	Total joint costs allocated (£)	Allocated to inventories (£)	Allocated to cost of good sold (£)
Product X	200 000	20 000 (10%)	180 000 (90%)	180 000	18 000 (10%)	162 000 (90%)
Product Y	100 000	30 000 (30%)	70 000 (70%)	300 000	90 000 (30%)	210 000 (70%)
Product Z	300 000	30 000 (10%)	270 000 (90%)	120 000	12 000 (10%)	108 000 (90%)
Total	600 000	80 000	520 000	600 000	120 000	480 000

There is a difference of £40 000 between the two methods in the costs allocated to inventories and cost of goods sold. Hence, reported profits will also differ by £40 000. The method chosen to allocate joint costs to products thus has a significant effect both on profit measurement and inventory valuation.

Net realizable value method

In Example 7.1 we have assumed that all products are sold at the split-off point and that no additional costs are incurred beyond that point. In practice, however, it is likely that joint products will be processed individually beyond the split-off point, and market values may not exist for the products at this stage. To estimate the sales value at the split-off point, it is therefore necessary to use the estimated sales value at the point of sale and work backwards. This method is called the **net realizable value method**. The net realizable value at split-off point can be estimated by deducting from the sales revenues the further processing costs at the point of sale. This approach is illustrated with the data given in Example 7.2 which is the same as Example 7.1 except that further processing costs beyond split-off point are now assumed to exist. You should now refer to Example 7.2.

The calculation of the net realizable value and the allocation of joint costs using this method is as follows:

Product	Sales value (£)	Costs beyond split-off point (£)	Estimated net realizable value at split-off point (£)	Proportion to total (%)	Joint costs allocated (£)	Profit (£)	Gross profit (%)
X	300 000	80 000	220 000	27.5	165 000	55 000	18.33
Y	500 000	100 000	400 000	50.0	300 000	100 000	20.00
Z	200 000	20 000	180 000	22.5	135 000	45 000	22.50
	1 000 000	200 000	800 000		600 000	200 000	20.00

Note that the joint costs are allocated in proportion to each product's net realizable value at split-off point.

Constant gross profit percentage method

When the products are subject to further processing after split-off point and the net realizable method is used, the gross profit percentages are different for each product. In the above illustration they are 18.33% for product X, 20% for Y and 22.5% for Z. It could be argued that, since the three products arise from a single productive process, they should earn identical gross profit percentages. The **constant gross profit percentage method** allocates joint costs so that the overall gross profit percentage is identical for each individual product. From the information contained in Example 7.2 the joint costs would be allocated in such a way that the resulting gross profit percentage for each of the three products is equal to the overall gross profit percentage of 20%. Note that the gross profit percentage is calculated by deducting the *total* costs of the three products (£800 000) from the *total* sales (£1 000 000) and expressing the profit (£200 000) as a percentage of sales. The calculations are as follows:

EXAMPLE 7.2

Assume the same situation as Example 7.1 except that further processing costs now apply. Details of the production process and sales revenues are given in the following diagram:



	Product X (£)	Product Y (£)	Product Z (£)	Total (£)
Sales value	300 000	500 000	200 000	1 000 000
Gross profit (20%)	60 000	100 000	40 000	200 000
Cost of goods sold	240 000	400 000	160 000	800 000
Less separable further processing costs	80 000	100 000	20 000	200 000
Allocated joint costs	160 000	300 000	140 000	600 000

You can see that the required gross profit percentage of 20% is computed for each product. The additional further processing costs for each product are then deducted, and the balance represents the allocated joint costs.

The constant gross profit percentage method implicitly assumes that there is a uniform relationship between cost and sales value for each individual product. However, such an assumption is questionable, since we do not observe identical gross profit percentages for individual products in multi-product companies that do not involve joint costs.

Comparison of methods

What factors should be considered in selecting the most appropriate method of allocating joint costs? The cause-and-effect criterion, described in Chapter 4, cannot be used because there is no cause-and-effect relationship between the *individual* products and the incurrence of joint costs. Joint costs are caused by *all* products and not by individual products. Where cause-and-effect relationships cannot be established allocations ought to be based on the benefits received criterion. If benefits received cannot be measured costs should be allocated based on the principle of equity or fairness. The net realizable method or the sales value at split-off point are the methods that best meet the benefits received criterion. The latter also has the added advantage of simplicity if sales values at the split-off point exist. It is also difficult to estimate the net realizable value in industries where there are numerous subsequent further processing stages and multiple split-off points. Similar measurement problems can also apply with the physical measures methods. In some industries a common denominator for physical measures for each product does not exist. For example, the output of the joint process may consist of a combination of solids, liquids and gases.

What methods do companies actually use? Little empirical evidence exists apart from a UK survey by Slater and Wootton (1984). Their survey findings are presented in Exhibit 7.1. You will see that a physical measures method is most widely used. In practice firms are likely to use a method where the output from the joint process can be measured without too much difficulty. Establishing a common output measure is extremely difficult in some organizations. To overcome this problem they value inventories at their estimated net realizable value minus a normal profit margin.

Irrelevance of joint cost allocations for decision-making

Our previous discussion has concentrated on the allocation of joint costs for inventory valuation and profit measurement. Joint product costs that have been computed for inventory valuation are entirely inappropriate for decision-making. For decision-making relevant costs should be used – these represent the incremental costs relating to a decision. Therefore costs that will be unaffected by a decision are classed as irrelevant. Joint-cost allocations are thus irrelevant for decision-making. Consider the information presented in Example 7.3.

The joint cost of £1 000 000 will be incurred irrespective of which decision is taken, and is not relevant for this decision. The information which is required for the decision is a comparison of the additional costs with the additional revenues from converting product Y into product Z. The following information should therefore be provided:

Additional revenue and costs from converting product Y into product Z	(£)
Additional revenues (50 000 × £2)	100 000
Additional conversion costs	60 000
Additional profit from conversion	40 000

The proof that profits will increase by £40 000 if conversion takes place is as follows:

	Convert to product Z (£)	Do not convert (£)
Sales	1 300 000	1 200 000
Total costs	1 060 000	1 000 000
Profits	240 000	200 000

The general rule is that it will be profitable to extend the processing of a joint product so long as the additional revenues exceed the additional costs.

Accounting for by-products

By-products are products that have a minor sales value and that emerge incidentally from the production of the major product. As the major objective of the company is to produce the joint products, it can justifiably be argued that the joint costs should be allocated only to the joint products and that the by-products should not be allocated with any portion of the joint cost that are incurred before the split-off point. Any costs that are incurred in producing by-products after the split-off point can justifiably be charged to the by-product, since such costs are incurred for the benefit of the by-product only.

EXHIBIT 7.1

Surveys of company practice

A survey of UK chemical and oil refining companies by Slater and Wootton (1984) reported the following methods of allocating joint costs:

	%
Physical measures method	76
Sales value method	5
Negotiated basis	19
Other	14

Note
The percentages add up to more than 100% because some companies used more than one method.

The analysis by industry indicated that the following methods were used:

Type of company	Predominant cost allocation method used
Petrochemicals	Sales value at split-off point or estimated net realizable method
Coal processing	Physical measures method
Coal chemicals	Physical measures method
Oil refining	No allocation of joint costs

The authors of the survey noted that it was considered by the majority of oil refineries that the complex nature of the process involved, and the vast number of joint product outputs, made it impossible to establish any meaningful cost allocation between products.

EXAMPLE 7.3

The Adriatic Company incurs joint product costs of £1 000 000 for the production of two joint products, X and Y. Both products can be sold at split-off point. However, if additional costs of £60 000 are incurred on product Y then it can be converted into product Z and sold for £10 per unit. The joint costs and the sales revenue at split-off point are illustrated in the following diagram:



You are requested to advise management whether or not product Y should be converted in product Z.

By-product revenues or by-product net revenues (the sales revenue of the by-product less the additional further processing costs after the split-off point) should be deducted from the cost of the joint products or the main product from which it emerges. Consider Example 7.4.

None of the joint costs shown in Example 7.4 is allocated to the by-product but the further processing costs of £5000 (5000 kg × £1) are charged to the by-product. The net revenues from the by-product of £20 000 (sales revenue of £25 000 less further processing costs of £5000) are deducted from the costs of the joint process (£3 020 000). Thus joint costs of £3 000 000 will be allocated to joint products A and B using one of the allocation methods described in this chapter. The accounting entries for the by-product will be as follows:

Dr By-product stock (5000 × £4)	20 000	
Cr Joint process WIP account		20 000

With the net revenue due from the production of the by-product:

Dr By-product stock	5000	
Cr Cash		5000

With the separable manufacturing costs incurred:

Dr Cash	25 000	
Cr By-product stock		25 000

With the value of by-products sales for the period.

By-products, scrap and waste

The terms 'by-products', 'scrap' and 'waste' are used to refer to outputs with little or no value. Because different people use these different terms to refer to the same thing, we shall briefly discuss the distinction between them.

Waste is a term used to describe material that has no value, or even negative value if it has to be disposed of at some cost. Examples include gases, sawdust, smoke and other unsaleable residues from the manufacturing process. Waste presents no accounting problems because it has no sales value, and therefore it is not included in the stock valuation.

By-products, as we have already seen, are those products that have a minor sales value and that emerge incidentally from the production of the major products.

Scrap also emerges as a consequence of the joint production process, but it is distinct from by-products in the sense that it is the leftover part of raw materials, whereas by-products are different from the material that went into the production process. The term 'scrap' is usually limited to material that has some minor sales value. Metal shavings with a minor sales value would normally be classified as scrap. When a product of minor sales value is processed beyond the split-off point, it should be considered as a by-product and not scrap, although the fact that a product will not be processed beyond the split-off point does not necessarily mean that it should be considered as scrap. The major distinguishing feature is that by-products are different from the materials that went into the production process.

EXAMPLE 7.4

The Neopolitan Company operates a manufacturing process which produces joint products A and B and by-product C. The joint costs of the manufacturing process are £3 020 000, incurred in the manufacture of:

Product A	30 000 kg
Product B	50 000 kg
Product C	5 000 kg

By-product C requires further processing at a cost of £1 per kg, after which it can be sold at £5 per kg.

The accounting procedures for scrap and by-products are fairly similar, and the accounting treatment which has already been outlined for by-products can also be applied to scrap.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Distinguish between joint products and by-products.**

  Both joint products and by-products arise from a joint production process whereby the products are not separately identifiable until after they have emerged from this joint process. Joint products have relatively high sales value whereas by-products have a low sales value compared with the sales value of a joint product. Joint products are also crucial to the commercial viability of an organization, whereas by-products are incidental.

- **Explain and identify the split-off point in a joint cost situation.**

  The split-off point is the point in the process when products become separately identifiable.

- **Explain the alternative methods of allocating joint costs to products.**

  Four different methods of allocating joint costs to products were described – physical measures, sales value at split-off point, net realizable value and gross profit percentage methods. The physical measures method simply allocates joint costs to individual products in proportion to their production volumes. The second method allocates joint costs to individual products based on their sales value at split-off point. If market prices of products at the split-off point do not exist, the sales value can be estimated using the net realizable method. With this method the net realizable values of the joint products at split-off point are estimated by deducting the further processing costs from the sales value at the point of sale. The gross profit percentage method allocates joint costs so that the overall gross profit percentage is identical for each product.

- **Discuss the arguments for and against each of the methods of allocating joint costs to products.**

  Cost should be allocated based on cause-and-effect relationships. Such relationships cannot be observed with joint products. When this situation occurs it is recommended that joint costs should be allocated based on the benefits received criterion. The advantage of the physical measures method is its simplicity but it suffers from the disadvantage that it can lead to a situation where the recorded joint cost inventory valuation for a product is in excess of its net realizable value. The sales value at split-off point suffers from the disadvantage that sales values for many joint products do not exist at the split-off point. The gross profit percentage method assumes that there is a uniform relationship between cost and sales value for each product. However, such a relationship is questionable since identical gross profit percentages for individual products in multi-product companies that do not have joint costs are not observed. Both the sales value at split-off point and the net realizable value methods most closely meet the benefits received criterion but the latter is likely to be the preferred method if sales values at the split-off point do not exist.

- **Present relevant financial information for a decision as to whether a product should be sold at a particular stage or further processed.**

  The joint costs allocated to products are irrelevant for decisions relating to further processing. Such decisions should be based on a comparison of the incremental costs with the incremental revenues arising from further processing. The presentation of relevant financial information for further processing decisions was illustrated using the data presented in Example 7.3.

- **Describe the accounting treatment of by-products.**

  By-product net-revenues should be deducted from the cost of the joint production process prior to allocating the costs to the individual joint products. The accounting treatment of by-products was illustrated with the data presented in Example 7.4.



Key terms and concepts

by-products (p. 196, p. 204, p. 206)
constant gross profit percentage method (p. 202)
further processing costs (p. 196)
joint products (p. 196)
net realizable value method (p. 202)
physical measures method (p. 197)
sales value at split-off point method (p. 199)
scrap (p. 206)
split-off point (p. 196)
waste (p. 206)

Key examination points

It is necessary to apportion joint costs to joint products for inventory valuation and profit measurement purposes. Remember that the costs calculated for inventory valuation purposes should not be used for decision-making purposes. Examination questions normally require joint product cost calculations and the presentation of information as to whether a product should be sold at split-off point or further processed (see the answers to Review problems 7.16 and 7.17). A common mistake with the latter requirement is to include joint cost apportionments. You should compare incremental revenues with incremental costs and indicate that, in the short term, joint costs are not relevant to the decision to sell at the split-off point or process further.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

7.1 Define joint costs, split-off point and further processing costs. (*p. 196*)

7.2 Distinguish between joint products and by-products. (*p. 196*)

7.3 Provide examples of industries that produce both joint products and by-products. (*p. 196*)

7.4 Explain why it is necessary to allocate joint costs to products. (*p. 196*)

7.5 Describe the four different methods of allocating joint costs to products. (*pp. 197–203*)

7.6 Why is the physical measure method considered to be an unsatisfactory joint-cost allocation method? (*pp. 198–99*)

7.7 Explain the factors that should influence the choice of method when allocating joint costs to products. (*pp. 203–4*)

7.8 Explain the financial information that should be included in a decision as to whether a product should be sold at the split-off point or further processed. (*p. 204*)

7.9 Describe the accounting treatment of by-products. (*pp. 204–6*)

7.10 Distinguish between by-products, waste and scrap. (*p. 206*)

Review problems

7.11 A company operates a process which produces three joint products – K, P and Z. The costs of operating this process during September amounted to £117 000. During the month the output of the three products was:

K	2000 litres
P	4500 litres
Z	3250 litres

P is further processed at a cost of £9.00 per litre. The actual loss of the second process was 10% of the input which was normal. Products K and Z are sold without further processing.

The final selling prices of each of the products are:

K	£20.00 per litre
P	£25.00 per litre
Z	£18.00 per litre

Joint costs are attributed to products on the basis of output volume.

The profit attributed to product P was:

A £6750
B £12 150
C £13 500
D £16 200
E £18 000

CIMA Stage 2 Specimen Paper

7.12 The output of a process consists of two joint products, Jointpro A and Jointpro B, and a by-product. Jointpro B could go through a further process in order to increase its sales value. To assist management in making the decision whether to carry out further processing, which ONE of the following is relevant?

A The share of the total processing cost which has been allocated to Jointpro B.
B The sales value of Jointpro A and the by-product.
C The physical quantities of all three products at separation point.
D The cost of further processing Jointpro B and the increase in sales value that will result.

CIMA – Management Accounting Fundamentals

7.13 Charleville operates a continuous process producing three products and one by-product. Output from the process for a month was as follows:

Product	Selling price per unit	Units of output from process
1	£18	10 000
2	£25	20 000
3	£20	20 000
4 (by-product)	£2	3 500

Total output costs were £277 000.

What was the unit valuation for product 3 using the sales revenue basis for allocating joint cost?

A £4.70
B £4.80
C £5.00
D £5.10.

ACCA Paper 1.2 – Financial Information for Management

7.14 **Apportionment of joint costs**

A business uses process costing to establish stock valuations and profitability of its products. Output from the process consists of three separate products: two joint products and a by-product. Details of the process is as follows:

Input costs:	
Materials	£45 625 for 12 500 kg
Labour	£29 500
Overheads	£26 875

The process is expected to lose 20% of the input. This is sold for scrap for £4 per unit.

The following details relate to the output from the process:

Product	Type	% of output	Final sales value per unit	Further costs to complete
A	Joint	50	£20	£10
B	Joint	40	£25	
C	By-product	10	£2	

Joint costs are allocated on the basis of net realizable value at split-off.

Required:

(a) Establish the total cost of the output from the process.

(4 marks)

(b) Calculate the profit per unit for each of the joint products, A and B.

(6 marks)

(10 marks)

ACCA Paper 1.2 – Financial Information for Management

7.15 Apportionment of joint costs

The marketing director of your company has expressed concern about product X, which for some time has shown a loss, and has stated that some action will have to be taken.

Product X is produced from material A which is one of two raw materials jointly produced by passing chemicals through a process.

Representative data for the process is as follows:

Output (kg):	
Material A	10 000
Material B	30 000
Process B (£):	
Raw material	83 600
Conversion costs	58 000

Joint costs are apportioned to the two raw materials according to the weight of output.

Production costs incurred in converting material A into product X are £1.80 per kg of material A used. A yield of 90% is achieved. Product X is sold for £5.60 per kg. Material B is sold without further processing for £6.00 per kg.

Required:

(a) Calculate the profit/loss per kg of product X and material B, respectively.
(7 marks)

(b) Comment upon the marketing director's concern, advising him whether you consider any action should be taken.
(7 marks)

(c) Demonstrate an alternative joint cost apportionment for product X and comment briefly upon this alternative method of apportionment.
(8 marks)

(Total 22 marks)

ACCA Level 1 Costing

7.16 Joint cost apportionment and decisions on further processing

A process costing £200 000 produces 3 products – A, B and C. Output details are as follows:

Product A	6 000 litres
Product B	10 000 litres
Product C	20 000 tonnes

Each product may be sold at the completion of the process as follows:

	Sales value at the end of the first process
Product A	£10 per litre
Product B	£4 per litre
Product C	£10 per tonne

Alternatively, further processing of each individual product can be undertaken to produce an enhanced product thus:

	Subsequent processing costs	Sales value after final process
Enhanced Product A	£14 per litre	£20 per litre
Enhanced Product B	£2 per litre	£8 per litre
Enhanced Product C	£6 per tonne	£16 per tonne

Required:

(a) Explain the following terms:
(i) normal process loss;
(ii) joint product;
(iii) by-product;
and state the appropriate costing treatments for normal process loss and for by-products.

(10 marks)

(b) Calculate the apportionment of joint process costs to products A, B and C above.

(8 marks)

(c) Explain whether the initial process should be undertaken and which, if any, of the enhanced products should be produced.

(7 marks)

(Total 25 marks)

AAT

7.17 Preparation of profit statements and decision on further processing

(a) Polimur Ltd operates a process that produces three joint products, all in an unrefined condition. The operating results of the process for October 2000 are shown below.

Output from process:

Product A	100 tonnes
Product B	80 tonnes
Product C	80 tonnes

The month's operating costs were £1 300 000. The closing stocks were 20 tonnes of A, 15 tonnes of B and 5 tonnes of C. The value of the closing stock is calculated by apportioning costs according to weight of output. There were no opening stocks and the balance of the output was sold to a refining company at the following prices:

Product A	£5 per kg
Product B	£4 per kg
Product C	£9 per kg

Required:

Prepare an operating statement showing the relevant trading results for October 2000.

(6 marks)

(b) The management of Polimur Ltd have been considering a proposal to establish their own refining operations.

The current market prices of the refined products are:

Product A	£17 per kg
Product B	£14 per kg
Product C	£20.50 per kg

The estimated unit costs of the refining operation are:

	Product A (£ per kg)	Product B (£ per kg)	Product C (£ per kg)
Direct materials	0.50	0.75	2.50
Direct labour	2.00	3.00	4.00
Variable overheads	1.50	2.25	5.50

Prime costs would be variable. Fixed overheads, which would be £700 000 monthly, would be direct to the refining operation. Special equipment is required for refining product B and this would be rented at a cost, not included in the above figures, of £360 000 per month.

It may be assumed that there would be no weight loss in the refining process and that the quantity refined each month would be similar to October's output shown in (a) above.

Required:

Prepare a statement that will assist management to evaluate the proposal to commence refining operations. Include any further comments or observations you consider relevant.

(16 marks)
(Total 22 marks)
ACCA Foundation Costing



Income effects of alternative cost accumulation systems

8

In the previous chapters we looked at the procedures necessary to ascertain product or job costs for inventory valuation to meet the requirements of external reporting. The approach that we adopted was to allocate all manufacturing cost to products, and to value unsold stocks at their total cost of manufacture. Non-manufacturing costs were not allocated to the products but were charged directly to the profit statement and excluded from the inventory valuation. A costing system based on these principles is known as an **absorption** or **full costing** system.

In this chapter we are going to look at an alternative costing system known as **variable costing**, **marginal costing** or **direct costing**. Under this alternative system, only variable manufacturing costs are assigned to products and included in the inventory valuation. Fixed manufacturing costs are not allocated to the product, but are considered as period costs and charged directly to the profit statement. Both absorption costing and variable costing systems are in complete agreement regarding the treatment of non-manufacturing costs as period costs. The disagreement between the proponents of absorption costing and the proponents of variable costing is concerned with whether or not manufacturing fixed overhead should be regarded as a period cost or a product cost. An illustration of the different treatment of fixed manufacturing overhead for both absorption and variable costing

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- explain the differences between an absorption costing and a variable costing system;
- prepare profit statements based on a variable costing and absorption costing system;
- explain the difference in profits between variable and absorption costing profit calculations;
- explain the arguments for and against variable and absorption costing.

systems is shown in Exhibit 8.1. You should note that in Exhibit 8.1 direct labour is assumed to be a variable cost. Generally direct labour is not a short term variable cost that varies in direct proportion to the volume of activity. It is a step fixed cost (see Chapter 2) that varies in the longer term. In other words, it is a long term variable cost. Because of this, variable costing systems generally assume that direct labour is a variable cost.

External and internal reporting

Many writers have argued the cases for and against variable costing for inventory valuation for external reporting. One important requirement for external reporting is consistency. It would be unacceptable if companies changed their methods of inventory valuation from year to year. In addition, inter-company comparison would be difficult if some companies valued their stocks on an absorption cost basis while others did so on a variable cost basis. Furthermore, the users of external accounting reports need reassurance that the published financial statements have been prepared in accordance with generally accepted standards of good accounting practice. Therefore there is a strong case for the acceptance of one method of stock valuation for external reporting. In the UK a Statement of Standard Accounting Practice on Stocks and Work in Progress was published by the Accounting Standards Committee (SSAP 9). This states:

> *In order to match costs and revenue, cost of stocks and work in progress should comprise that expenditure which has been incurred in the normal course of business in bringing the product or service to its present location and condition. Such costs will include all related production overheads, even though these may accrue on a time basis.*

The effect of this statement in SSAP 9 was to require absorption costing for external reporting and for non-manufacturing costs to be treated as period costs. The International Accounting Standard on Inventories (IAS2) also requires that companies in other countries adopt absorption costing (see Exhibit 8.4 shown on page 226).

In spite of the fact that absorption costing is required for external reporting, the variable costing versus absorption costing debate is still of considerable importance for internal reporting. Management normally require profit statements at monthly or quarterly intervals, and will no doubt wish to receive separate profit statements for each major product group or segment of the business. This information is particularly useful in evaluating the performance of divisional managers. Management must therefore decide whether absorption costing or variable costing provides the more meaningful information in assessing the economic and managerial performance of the different segments of the business.

However, before discussing the arguments for and against absorption and variable costing, let us look at a simple illustration of both methods using Example 8.1. To keep things simple we shall assume that the company in this example produces only one product using a single overhead rate for the company as a whole, with units of output being used as the allocation base. These assumptions are very simplistic. As indicated in Chapter 4, most companies are multi-product companies and they do not use a single company or plant-wide overhead rate. Instead, many cost centres are established, each with their own allocation base. Nevertheless, the same general principles apply to both simplistic and complex product settings relating to the impact that

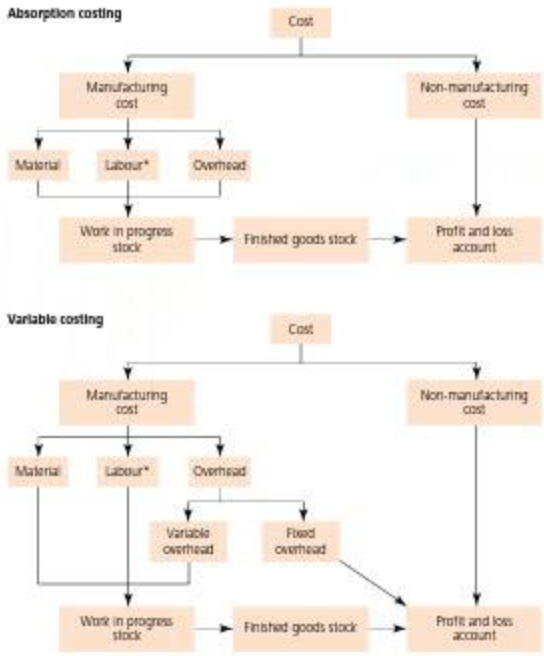


EXHIBIT 8.1

Absorption and variable costing systems

variable and absorption costing have on profit measurement and inventory valuation. A more complex example would not enhance your understanding of the issues involved. You should now refer to Example 8.1.

Variable costing

The variable costing profit statements are shown in Exhibit 8.2. You will see that when a system of variable costing is used, the product cost is £6 per unit, and includes variable costs only since variable costs are assigned to the product. In period 1 production is 150 000 units at a variable cost of £6 per unit. The total fixed costs are

EXAMPLE 8.1

The following information is available for periods 1–6 for the Hoque Company:

	(£)
Unit selling price	10
Unit variable cost	6
Fixed costs per each period	300 000

The company produces only one product. Budgeted activity is expected to average 150 000 units per period, and production and sales for each period are as follows:

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Units sold (000s)	150	120	180	150	140	160
Units produced (000s)	150	150	150	150	170	140

There were no opening stocks at the start of period 1, and the actual manufacturing fixed overhead incurred was £300 000 per period. We shall also assume that non-manufacturing overheads are £100 000 per period.

EXHIBIT 8.2

Variable costing statements

	Period 1 (£000s)	Period 2 (£000s)	Period 3 (£000s)	Period 4 (£000s)	Period 5 (£000s)	Period 6 (£000s)
Opening stock	—	—	180	—	—	180
Production cost	900	900	900	900	1020	840
Closing stock	—	(180)	—	—	(180)	(60)
Cost of sales	900	720	1080	900	840	960
Fixed costs	300	300	300	300	300	300
Total costs	1200	1020	1380	1200	1140	1260
Sales	1500	1200	1800	1500	1400	1600
Gross profit	300	180	420	300	260	340
Less non-manufacturing costs	100	100	100	100	100	100
Net profit	200	80	320	200	160	240

then added separately to produce a total manufacturing cost of £1 200 000. Note that the fixed costs of £300 000 are assigned to the period in which they are incurred.

In period 2, 150 000 units are produced but only 120 000 are sold. Therefore 30 000 units remain in stock at the end of the period. In order to match costs with revenues, the sales of 120 000 units should be matched with costs for 120 000. As 150 000 units were produced, we need to value the 30 000 units in stock and deduct this sum from the production cost. Using the variable costing system, the 30 000 units in stock are

valued at £6 per unit. A closing inventory of £180 000 will then be deducted from the production costs, giving a cost of sales figure of £720 000. Note that the closing inventory valuation does not include any fixed overheads.

The 30 000 units of closing inventory in period 2 becomes the opening inventory for period 3 and therefore an expense for this period. The production cost for the 150 000 units made in period 3 is added to this opening inventory valuation. The overall effect is that costs for 180 000 units are matched against sales for 180 000 units. The profits for periods 4–6 are calculated in the same way.

Absorption costing

Let us now consider in Exhibit 8.3 the profit calculations when closing stocks are valued on an absorption costing basis. With the absorption costing method, a share of the fixed production overheads are allocated to individual products and are included in the products' production cost. Fixed overheads are assigned to products by establishing overhead absorption rates as described in Chapter 4. To establish the overhead rate we must divide the fixed overheads of £300 000 for the period by an appropriate denominator level. Most companies use an annual budgeted activity measure of the overhead allocation base as the denominator level. Our allocation base in Example 8.1 is units of output and we shall assume that the annual budgeted output is 1 800 000 units giving an average for each monthly period of 150 000 units. Therefore the budgeted fixed overhead rate is £2 per unit (£300 000/150 000 units). The product cost now consists of a variable cost (£6) plus a fixed manufacturing cost (£2), making a total of £8 per unit. Hence, the production cost for period 1 is £1 200 000 (150 000 units at £8).

Now compare the absorption costing statement (Exhibit 8.3) with the variable costing statement (Exhibit 8.2) for period 1. With absorption costing, the fixed cost is included in the production cost figure, whereas with variable costing only the variable cost is included. With variable costing, the fixed cost is allocated separately as a lump sum and is not included in the cost of sales figure. Note also that the closing inventory of 30 000 units for period 2 is valued at £8 per unit in the absorption costing statement, whereas the closing inventory is valued at only £6 in the variable costing statement.

In calculating profits, the matching principle that has been applied in the absorption costing statement is the same way as that described for variable costing. However, complications arise in periods 5 and 6; in period 5, 170 000 units were produced, so the production cost of £1 360 000 includes fixed overheads of £340 000 (170 000 units at £2). The total fixed overheads incurred for the period are only £300 000, so £40 000 too much has been allocated. This over recovery of fixed overhead is recorded as a **period cost adjustment**. (A full explanation of under- and over- recoveries of overheads and the reasons for period cost adjustments was presented in Chapter 4; if you are unsure of this concept, please refer back now to the section headed 'Under- and over- recovery of overheads'.) Note also that the under- or over-recovery of fixed overheads is also called **volume variance**.

In period 6, 140 000 units were produced at a cost of £1 120 000, which included only £280 000 (140 000 units at £2) for fixed overheads. As a result, there is an under recovery of £20 000, which is written off as a period cost. You can see that an under or over recovery of fixed overhead occurs whenever actual production differs from the budged average level of activity of 150 000 units, since the calculation of the fixed overhead rate of £2 per unit was based on the assumption that actual production would be 150 000 units per period. Note that both variable and absorption costing systems do not assign non-manufacturing costs to products for stock valuation.

EXHIBIT 8.3
Absorption costing statements

	Period 1 (£000s)	Period 2 (£000s)	Period 3 (£000s)	Period 4 (£000s)	Period 5 (£000s)	Period 6 (£000s)
Opening stock	—	—	240	—	—	240
Production cost	1200	1200	1200	1200	1360	1120
Closing stock	—	(240)	—	—	(240)	(80)
Cost of sales	1200	960	1440	1200	1120	1280
Adjustments for under/(over) recovery of overhead	—	—	—	—	(40)	20
Total costs	1200	960	1440	1200	1080	1300
Sales	1500	1200	1800	1500	1400	1600
Gross profit	300	240	360	300	320	300
Less non-manufacturing costs	100	100	100	100	100	100
Net profit	200	140	260	200	220	200

Variable costing and absorption costing: a comparison of their impact on profit

A comparison of the variable costing and absorption costing statements produced from the information contained in Example 8.1 reveals the following differences in profit calculations:

(a) The profits calculated under the absorption costing and variable costing systems are identical for periods 1 and 4.

(b) The absorption costing profits are higher than the variable costing profits in periods 2 and 5.

(c) The variable costing profits are higher than the absorption costing profits in periods 3 and 6.

Let us now consider each of these in a little more detail.

Production equals sales

In periods 1 and 4 the profits are the same for both methods of costing; in both periods production is equal to sales, and inventories will neither increase nor decrease. Therefore if opening inventories exist, the same amount of fixed overhead will be carried forward as an expense to be included in the current period in the opening inventory valuation as will be deducted in the closing inventory valuation from the production cost figure. The overall effect is that, with an absorption costing system, the only fixed overhead that will be included as an expense for the period will be the amount of fixed overhead that is incurred for the period. Thus, whenever sales are equal to production the profits will be the same for both the absorption costing and variable costing systems.

Production exceeds sales

In periods 2 and 5 the absorption costing system produces higher profits; in both periods production exceeds sales. Profits are higher for absorption costing when production is in excess of sales, because inventories are increasing. The effect of this is that a greater amount of fixed overheads in the closing inventory is being deducted from the expenses of the period than is being brought forward in the opening inventory for the period. For example, in period 2 the opening inventory is zero and no fixed overheads are brought forward from the previous period. However, a closing inventory of 30 000 units means that a £60 000 fixed overhead has to be deducted from the production cost for the period. In other words, only £240 000 is being allocated for fixed overhead with the absorption costing system, whereas the variable costing system allocates the £300 000 fixed overhead incurred for the period. The effect of this is that profits are £60 000 greater with the absorption costing system. As a general rule, if production is in excess of sales, the absorption costing system will show a higher profit than the variable costing system.

Sales exceed production

In periods 3 and 6 the variable costing system produces higher profits; in both periods sales exceed production. When this situation occurs, inventories decline and a greater amount of fixed overheads will need to be brought forward as an expense in the opening inventory than is being deducted in the closing inventory adjustment. For example, with the absorption costing system, in period 6, 30 000 units of opening inventory are brought forward, so that fixed costs of £60 000 are included in the inventory valuation. However, a closing inventory of 10 000 units requires a deduction of £20 000 fixed overheads from the production costs. The overall effect is that an additional £40 000 fixed overheads is included as an expense within the stock movements, and a total of £340 000 fixed overheads is allocated for the period. The variable costing system, on the other hand, would allocate fixed overheads for the period of only £300 000. As a result, profits are £40 000 greater with the variable costing system. As a general rule, if sales are in excess of production, the variable costing system will show a higher profit than the absorption costing system.

Impact of sales fluctuations

The profit calculations for an absorption costing system can produce some strange results. For example, in period 6 the sales volume has increased but profits have declined, in spite of the fact that both the selling price and the cost structure have remained unchanged. A manager whose performance is being judged in period 6 is likely to have little confidence in an accounting system that shows a decline in profits when sales volume has increased and the cost structure and selling price have not changed. The opposite occurs in period 5. In this period the sales volume declines but profit increases. The situations in periods 5 and 6 arise because the under- or over-recovery of fixed overhead is treated as a period cost, and such adjustments can at times give a misleading picture of profits.

In contrast, the variable costing profit calculations show that when sales volume increases profit also increases. Alternatively, when sales volume decreases, profit also decreases. These relationships continue as long as the selling price and cost structure remain unchanged. Looking again at the variable costing profit calculations, you will note that profit declines in period 5 when the sales volume declines, and increases in

period 6 when the sales volume also increases. The reasons for these changes are that, with a system of variable costing, profit is a function of sales volume only, when the selling price and cost structure remain unchanged. However, with absorption costing, profit is a function of both sales volume and production volume.

A mathematical model of the profit functions

In Appendix 8.1 the following formula is developed to model the profit function for an absorption costing system when unit costs remain unchanged throughout the period:

$$OPBT_{AC} = (ucm - ufmc)Q_s + (ufmc \times Q_p) - FC \quad (8.1)$$

where

ucm = Contribution margin per unit (i.e. selling price per unit – variable cost per unit)
ufmc = Predetermined fixed manufacturing overhead per unit of output
Q_p = Number of units produced
Q_s = Number of units sold
FC = Total fixed costs (manufacturing and non-manufacturing)
$OPBT_{AC}$ = Operating profit before taxes for the period (Absorption costing)
$OPBT_{VC}$ = Operating profit before taxes for the period (Variable costing)

Applying formula 8.1 to the data given in Example 8.1 gives the following profit function:

$$(£4 - £2)Q_s + (£2 \times Q_p) - £400\,000 = £2Q_s + £2Q_p - £400\,000$$

Applying the above profit function to periods 4–6 we get:

Period 4 = £2(150 000) + £2(150 000) – £400 000 = £200 000
Period 5 = £2(140 000) + £2(170 000) – £400 000 = £220 000
Period 6 = £2(160 000) + £2(140 000) – £400 000 = £200 000

When production equals sales identical profits with an absorption and variable costing system are reported. Therefore formula 8.1 converts to the following variable costing profit function if we let $Q_s = Q_p$:

$$\text{Variable costing operating profit} = ucm \cdot Q_s - FC \quad (8.2)$$

Using the data given in Example 8.1 the profit function is:

$$£4Q_s - £400\,000$$

Applying the above profit function to periods 4–6 we get:

Period 4 = £4(150 000) – £400 000 = £200 000
Period 5 = £4(140 000) – £400 000 = £160 000
Period 6 = £4(160 000) – £400 000 = £240 000

The difference between the reported operating profits for an absorption costing and a variable costing system can be derived by deducting formulae 8.2 from 8.1 giving:

$$\text{ufmc}(Q_p - Q_s) \tag{8.3}$$

If you look closely at the above term you will see that it represents the inventory change (in units) multiplied by the fixed manufacturing overhead rate. Applying formula 8.3 to period 5 the inventory change ($Q_p - Q_s$) is 30 000 units (positive) so that absorption costing profits exceed variable costing profits by £60 000 (30 000 units at £2 overhead rate). For an explanation of how formulae (8.1) and (8.2) are derived you should refer to Appendix 8.1.

Some arguments in support of variable costing

Variable costing provides more useful information for decision-making

The separation of fixed and variable costs helps to provide relevant information about costs for making decisions. Relevant costs are required for a variety of short-term decisions, for example whether to make a component internally or to purchase externally, as well as problems relating to product-mix. These decisions will be discussed in Chapter 10. In addition, the estimation of costs for different levels of activities requires that costs be split into their fixed and variable elements. The assumption is that only with a variable costing system will such an analysis of costs be available. It is therefore assumed that projection of future costs and revenues for different activity levels, and the use of relevant cost decision-making techniques, are possible only if a variable costing system is adopted. There is no reason, however, why an absorption costing system cannot be used for profit measurement and inventory valuation and costs can be analysed into their fixed and variable elements for decision-making. The advantage of variable costing is that the analysis of variable and fixed costs is highlighted. (Such an analysis is not a required feature of an absorption costing system.)

Variable costing removes from profit the effect of inventory changes

We have seen that, with variable costing, profit is a function of sales volume, whereas, with absorption costing, profit is a function of both sales and production. We have also learned, using absorption costing principles, that it is possible for profit to decline when sales volumes increase. Where stock levels are likely to fluctuate significantly, profits may be distorted when they are calculated on an absorption costing basis, since the stock changes will significantly affect the amount of fixed overheads allocated to an accounting period.

Fluctuating stock levels are less likely to occur when one measures profits on an annual basis, but on a monthly or quarterly basis seasonal variations in sales may cause significant fluctuations. As profits are likely to be distorted by an absorption costing system, there are strong arguments for using variable costing methods when profits are measured at frequent intervals. Because frequent profit statements are presented only for management, the argument for variable costing is stronger for management

accounting. A survey by Drury *et al.* (1993) relating to 300 UK companies reported that 97% of the companies prepared profit statements at monthly intervals. Financial accounts are presented for public release annually or at half-yearly intervals; because significant changes in stock levels are less likely on an annual basis, the argument for the use of variable costing in financial accounting is not as strong.

A further argument for using variable costing for internal reporting is that the internal profit statements may be used as a basis for measuring managerial performance. Managers may deliberately alter their inventory levels to influence profit when an absorption costing system is used; for example, it is possible for a manager to defer deliberately some of the fixed overhead allocation by unnecessarily increasing stocks over successive periods.

There is a limit to how long managers can continue to increase stocks, and eventually the situation will arise when it is necessary to reduce them, and the deferred fixed overheads will eventually be allocated to the periods when the inventories are reduced. Nevertheless, there is likely to remain some scope for manipulating profits in the short term. Also senior management can implement control performance measures to guard against such behaviour. For example, the reporting of performance measures that monitor changes in inventory volumes will highlight those situations where managers are manipulating profits by unnecessarily increasing inventory levels.

Variable costing avoids fixed overheads being capitalized in unsaleable stocks

In a period when sales demand decreases, a company can end up with surplus stocks on hand. With an absorption costing system, only a portion of the fixed overheads incurred during the period will be allocated as an expense because the remainder of the fixed overhead will be included in the valuation of the surplus stocks. If these surplus stocks cannot be disposed of, the profit calculation for the current period will be misleading, since fixed overheads will have been deferred to later accounting periods. However, there may be some delay before management concludes that the stocks cannot be sold without a very large reduction in the selling price. The stocks will therefore be over-valued, and a stock write-off will be necessary in a later accounting period. The overall effect may be that the current period's profits will be overstated.

Some arguments in support of absorption costing

Absorption costing does not understate the importance of fixed costs

Some people argue that decisions based on a variable costing system may concentrate only on sales revenues and variable costs and ignore the fact that fixed costs must be met in the long run. For example, if a pricing decision is based on variable costs only, then sales revenue may be insufficient to cover all the costs. It is also argued that the use of an absorption costing system, by allocating fixed costs to a product, ensures that fixed costs will be covered. These arguments are incorrect. Absorption costing will not ensure that fixed costs will be recovered if actual sales volume is less than the estimate used to calculate the fixed overhead rate. For example, consider a situation where fixed costs are £100 000 and an estimated normal activity of 10 000 units is used to

calculate the overhead rate. Fixed costs are recovered at £10 per unit. Assume that variable cost is £5 per unit and selling price is set at £20 (total cost plus one-third). If actual sales volume is 5000 units then total sales revenue will be £100 000 and total costs will be £125 000. Total costs therefore exceed total sales revenue. The argument that a variable costing system will cause managers to ignore fixed costs is based on the assumption that such managers are not very bright! A failure to consider fixed costs is due to faulty management and not to a faulty accounting system. Furthermore, using variable costing for inventory valuation and profit measurement still enables full cost information to be extracted for pricing decisions.

Absorption costing avoids fictitious losses being reported

In a business that relies on seasonal sales and in which production is built up outside the sales season to meet demand the full amount of fixed overheads incurred will be charged, in a variable costing system, against sales. However, in those periods where production is being built up for sales in a later season, sales revenue will be low but fixed costs will be recorded as an expense. The result is that losses will be reported during out-of-season periods, and large profits will be reported in the periods when the goods are sold.

By contrast, in an absorption costing system fixed overheads will be deferred and included in the closing inventory valuation, and will be recorded as an expense only in the period in which the goods are sold. Losses are therefore unlikely to be reported in the periods when stocks are being built up. In these circumstances absorption costing appears to provide the more logical profit calculation.

Fixed overheads are essential for production

The proponents of absorption costing argue that the production of goods is not possible if fixed manufacturing costs are not incurred. Consequently, fixed manufacturing overheads should be allocated to units produced and included in the inventory valuation.

Consistency with external reporting

Top management may prefer their internal profit reporting systems to be consistent with the external financial accounting absorption costing systems so that they will be congruent with the measures used by financial markets to appraise overall company performance. In a pilot study of six UK companies Hopper *et al.* (1992) observed that senior managers are primarily interested in financial accounting information because it is perceived as having a major influence on how financial markets evaluate companies and their management. If top management believe that financial accounting information does influence share prices then they are likely to use the same rules and procedures for both internal and external profit measurement and inventory valuation so that managers will focus on the same measures as those used by financial markets. Also the fact that managerial rewards are often linked to external financial measures provides a further motivation to ensure that internal accounting systems do not conflict with external financial accounting reporting requirements.

EXHIBIT 8.4
Surveys of company practice

Surveys have been undertaken in many countries relating to the use of variable costs and absorption costs. However, these surveys tend to focus on the information that is extracted from the costing system for decision-making rather than the costs that are used for inventory valuation and profit measurement. Many organizations accumulate and use absorption costs for inventory valuation but extract variable costs from the cost system for decision-making. Thus, the use of variable cost for decision-making does not imply that such costs are used for inventory valuation. Surveys that do not clearly indicate the costing method that is used for inventory valuation are therefore not included in the results reported below.

A UK study by Drury *et al.* (1993) indicated the following usage rates for internal profit measurement:

	(%)
Variable costing	13
Absorption costing	84
Other	3

A review of surveys of German organizations undertaken by Scherrer (1996) concluded that full costing is the most important system with only 12% of the responding organizations using only a variable costing system.

Similar results were observed in Spain by Saez-Torrecilla *et al.* (1996) who reported a 26% usage rate for variable costing.

In contrast, Virtanen *et al.* (1996) report that variable costing is widely used in Finland mainly because external financial accounting reporting regulations have not forced companies to use absorption costing for external reporting.

Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain the differences between an absorption costing and a variable costing system.**

  With an absorption costing system, fixed manufacturing overheads are allocated to the products and these are included in the inventory valuations. With a variable costing system, only variable manufacturing costs are assigned to the product; fixed manufacturing costs are regarded as period costs and written off as a lump sum to the profit and loss account. Both variable and absorption costing systems treat non-manufacturing overheads as period costs.

- **Prepare profit statements based on a variable costing and absorption costing system.**

  With a variable costing system manufacturing fixed costs are added to the variable manufacturing cost of sales to determine total manufacturing costs to be deducted from sales revenues. Manufacturing fixed costs are assigned to products with an absorption costing system. Therefore, manufacturing cost of

sales is valued at full cost (manufacturing variable costs plus manufacturing fixed costs). With an absorption costing system fixed manufacturing costs are unitized by dividing the total manufacturing costs by estimated output. If actual output differs from estimated output an under- or over-recovery of overheads arises. This is recorded as a period cost adjustment in the current accounting period. The preparation of profit statements for absorption and variable costing systems was illustrated using Example 8.1.

- **Explain the difference in profits between variable and absorption costing profit calculations.**

  When production exceeds sales, absorption costing systems report higher profits. Variable costing systems yield higher profits when sales exceed production. Nevertheless, total profits over the life of the business will be the same for both systems. Differences arise merely in the profits attributed to each accounting period.

- **Explain the arguments for and against variable and absorption costing.**

  The proponents of variable costing claim that it enables more useful information to be presented for decision-making but such claims are questionable since similar relevant cost information can easily be extracted from an absorption costing system. The major advantage of variable costing is that profit is reflected as a function of sales, whereas, with an absorption costing system, profit is a function of both sales and production. It is possible with absorption costing, when all other factors remain unchanged, for sales to increase and profit to decline. In contrast, with a variable costing system, when sales increase, profits also increase. A further advantage of variable costing is that fixed overheads are not capitalized in unsaleable stocks. The arguments that have been made supporting absorption costing include: (a) absorption costing does not understate the importance of fixed costs; (b) absorption costing avoids the possibility of fictitious losses being reported; (c) fixed manufacturing overheads are essential to production and therefore should be incorporated in the product costs, and (d) internal profit measurement should be consistent with absorption costing profit measurement that is used for external reporting requirements.

Appendix 8.1: Derivation of the profit function for an absorption costing system

Using the notation listed in Exhibit 8A.1 the variable costing profit function can be expressed in equation form as follows:

$$\begin{aligned} OPBT_{VC} &= \text{Sales} - \text{Variable manufacturing costs of goods sold} \\ &\quad - \text{non-manufacturing variable costs} - \text{All fixed costs} \\ &= usp \cdot Q_s - uvmc \cdot Q_s - uvnmc \cdot Q_s - FC \qquad (8.A1) \\ &= ucm \cdot Q_s - FC \text{ (Note that the term contribution margin is used to describe unit selling price less unit variable cost)} \end{aligned}$$

The distinguishable feature between absorption costing and variable costing relates to the timing of the recognition of fixed manufacturing overheads (FC_{ip}) as an expense. Variable costing expenses fixed manufacturing overheads in the period that they are

EXHIBIT 8A.1
Summary of notation used

ucm = Contribution margin per unit (i.e. selling price per unit – variable cost per unit)
usp = Selling price per unit
uvmc = Variable manufacturing cost per unit
uvnmc = Variable non-manufacturing cost per unit
ufmc = Predetermined fixed manufacturing overhead per unit of output
Q_p = Number of units produced
Q_s = Number of units sold
FC = Total fixed costs (manufacturing and non-manufacturing)
FC_m = Total fixed manufacturing costs
FCnmc = Total fixed manufacturing costs
$OPBT_{AC}$ = Operating profit before taxes for the period (Absorption costing)
$OPBT_{VC}$ = Operating profit before taxes for the period (Variable costing)

incurred, whereas absorption costing assigns fixed manufacturing overheads to the units produced, thus recording them as an expense in the period in which the units are sold. The only difference between the two methods is that absorption costing incorporates some of the manufacturing fixed overheads in inventory. Therefore variable and absorption costing reported profits will differ by the amount of fixed manufacturing overheads that are included in the change in opening and closing inventories. This is equivalent to the difference between production and sales volumes multiplied by the manufacturing fixed overhead absorption rate.

We can therefore use equation (8.A1) as the basis for establishing the equation for the absorption costing profit function:

$$\begin{aligned} OPBT_{AC} &= ucm \cdot Q_s - FC + (Q_p - Q_s)ufmc \\ &= ucm \cdot Q_s - FC + (Q_p \times ufmc) - (Q_s \times ufmc) \\ &= (ucm - ufmc)Q_s + (ufmc \times Q_p) - FC \end{aligned} \qquad (8.A2)$$



Key terms and concepts

absorption costing (p. 215)
direct costing (p. 215)
full costing (p. 215)
marginal costing (p. 215)
period cost adjustment (p. 219)
variable costing (p. 215)
volume variance (p. 219)

Key examination points

A common mistake is for students to calculate *actual* overhead rates when preparing absorption costing profit statements. Normal or budgeted activity should be used to calculate overhead absorption rates, and this rate should be used to calculate the

production overhead cost for all periods given in the question. Do not calculate different actual overhead rates for each accounting period.

Remember not to include non-manufacturing overheads in the inventory valuations for both variable and absorption costing. Also note that variable selling overheads will vary with sales and not production. Another common mistake is not to include an adjustment for under- or over-recovery of fixed overheads when actual production deviates from the normal or budgeted production. You should note that under- or over-recovery of overhead arises only with fixed overheads and when an absorption costing system is used.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. Bohemia Industries is a case that is relevant to the content of this chapter.

Review questions

8.1 Distinguish between variable costing and absorption costing. *(pp. 215–6)*

8.2 How are non-manufacturing fixed costs treated under absorption and variable costing systems? *(p. 215)*

8.3 Describe the circumstances when variable and absorption costing systems will report identical profits. *(p. 220)*

8.4 Under what circumstances will absorption costing report higher profits than variable costing? *(p. 221)*

8.5 Under what circumstances will variable costing report higher profits than absorption costing? *(p. 221)*

8.6 What arguments can be advanced in favour of variable costing? *(pp. 223–4)*

8.7 What arguments can be advanced in favour of absorption costing? *(pp. 224–5)*

8.8 Explain how absorption costing can encourage managers to engage in behaviour that is harmful to the organization. *(p. 224)*

Review problems

8.9 Z Limited manufactures a single product, the budgeted selling price and variable cost details of which are as follows:

	(£)
Selling price	15.00
Variable costs per unit:	
Direct materials	3.50
Direct labour	4.00
Variable overhead	2.00

Budgeted fixed overhead costs are £60 000 per annum, charged at a constant rate each month. Budgeted production is 30 000 units per annum.

In a month when actual production was 2400 units and exceeded sales by 180 units the profit reported under absorption costing was

A £6660
B £7570
C £7770
D £8200
E £8400

CIMA Stage 2

8.10 A company which uses marginal costing has a profit of £37 500 for a period. Opening stock was 100 units and closing stock was 350 units.

The fixed production overhead absorption rate is £4 per unit.

What is the profit under absorption costing?

A £35 700
B £36 500
C £38 500
D £39 300

ACCA Paper 1.2 – Financial Information for Management

8.11 A company produces and sells a single product whose variable cost is £6 per unit.

Fixed costs have been absorbed over the normal level of activity of 200 000 units and have been calculated as £2 per unit.

The current selling price is £10 per unit.

How much profit is made under marginal costing if the company sells 250 000 units?

A £500 000
B £600 000
C £900 000
D £1 000 000

ACCA Paper 1.2 – Financial Information for Management

8.12 A newly formed company has drawn up the following budgets for its first two accounting periods:

	Period 1	Period 2
Sales units	9 500	10 300
Production units (equivalent to normal capacity)	10 000	10 000

The following budgeted information applies to both periods:

	$
Selling price per unit	6.40
Variable cost per unit	3.60
Fixed production overhead per period	15 000

(a) In period 1, the budgeted profit will be
(i) the same under both absorption costing and marginal costing.
(ii) $750 higher under marginal costing.
(iii) $750 higher under absorption costing.
(iv) $1400 higher under absorption costing.

(b) In period 2, everything was as budgeted, except for the fixed production overhead, which was $15 700.

The reported profit, using absorption costing in period 2, would be
(i) $12 300
(ii) $12 690
(iii) $13 140
(iv) $13 840

CIMA – Management Accounting Fundamentals

8.13 Exe Limited makes a single product whose total cost per unit is budgeted to be £45. This includes fixed cost of £8 per unit based on a volume of 10 000 units per period. In a period, sales volume was 9000 units, and production volume was 11 500 units. The actual profit for the same period, calculated using absorption costing, was £42 000.

If the profit statement were prepared using marginal costing, the profit for the period

A would be £10 000
B would be £22 000
C would be £50 000
D would be £62 000
E cannot be calculated without more information

CIMA Stage 1 Operational Cost Accounting

8.14 In a period, opening stocks were 12 600 units and closing stocks 14 100 units. The profit based on marginal costing was £50 400 and profit using absorption costing was £60 150. The fixed overhead absorption rate per unit (to the nearest penny) is

A £4.00
B £4.27
C £4.77
D £6.50

CIMA Stage 1 Cost Accounting

8.15 Which of the following statements are correct with regard to marginal costing?

(i) Period costs are costs treated as expenses in the period incurred.
(ii) Product costs can be identified with goods produced.
(iii) Unavoidable costs are relevant for decision making.

A (i), (ii) and (iii)
B (i) and (ii) only
C (i) and (iii) only
D (ii) and (iii) only.

ACCA Paper 1.2 – Financial information for Management

8.16 Preparation of variable and absorption costing profit statements

Oathall Limited, which manufactures a single product, is considering whether to use marginal or absorption costing to report its budgeted profit in its management accounts.

The following information is available:

	£/unit
Direct materials	4
Direct labour	15
	19
Selling price	50

Fixed production overheads are budgeted to be £300 000 per month and are absorbed on an activity level of 100 000 units per month.

For the month in question, sales are expected to be 100 000 units although production units will be 120 000 units.

Fixed selling costs of £150 000 per month will need to be included in the budget as will the variable selling costs of £2 per unit.

There are no opening stocks.

Required:

(a) Prepare the budgeted profit and loss account for a month for Oathall Limited using absorption costing. Clearly show the valuation of any stock figures.
(6 marks)

(b) Prepare the budgeted profit and loss account for a month for Oathall Limited using marginal costing. Clearly show the valuation of any stock figures.
(4 marks)
(10 marks)
ACCA Paper 1.2 – Financial Information for Management

8.17 Preparation of variable and absorption costing statements and an explanation of the differences in profits.

Bittern Ltd manufactures and sells a single product at a unit selling price of £25. In constant-price-level terms its cost structure is as follows:

Variable costs:	
Production materials	£10 per unit produced
Distribution	£1 per unit sold
Semi-variable costs:	
Labour	£5000 per annum, plus £2 per unit produced
Fixed costs:	
Overheads	£5000 per annum

For several years Bittern has operated a system of variable costing for management accounting purposes. It has been decided to review the system and to compare it for management accounting purposes with an absorption costing system.

As part of the review, you have been asked to prepare estimates of Bittern's profits in constant-price-level terms over a three-year period in three different hypothetical situations, and to compare the two types of system generally for management accounting purposes.

(a) In each of the following three sets of hypothetical circumstances, calculate Bittern's profit in each of years t_1, t_2 and t_3, and also in total over the three year period t_1 to t_3, using first a variable costing system and then a full-cost absorption costing system with fixed cost recovery based on a normal production level of 1000 units per annum:

(i) Stable unit levels of production, sales and inventory

	t_1	t_2	t_3
Opening stock	100	100	100
Production	1000	1000	1000
Sales	1000	1000	1000
Closing stock	100	100	100

(5 marks)

(ii) Stable unit level of sales, but fluctuating unit levels of production and inventory

	t_1	t_2	t_3
Opening stock	100	600	400
Production	1500	800	700
Sales	1000	1000	1000
Closing stock	600	400	100

(5 marks)

(iii) Stable unit level of production, but fluctuating unit levels of sales and inventory

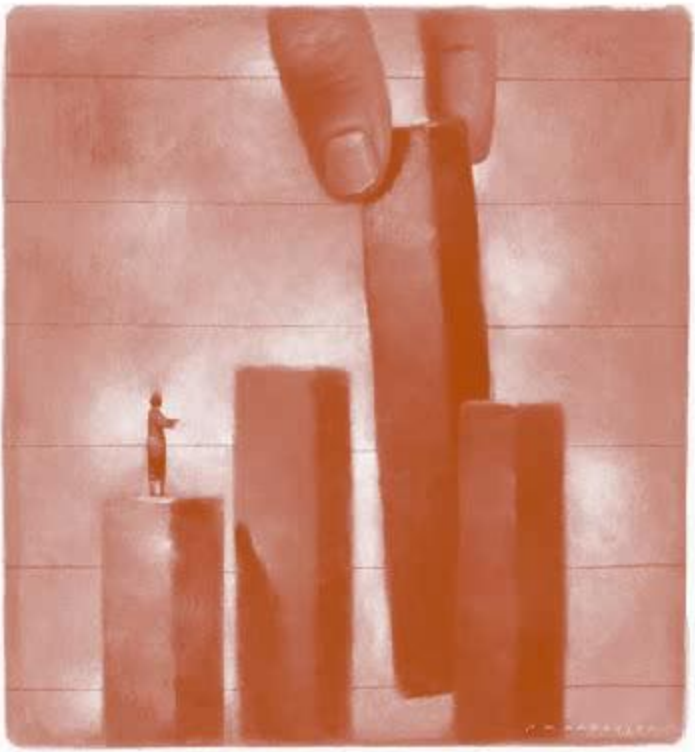
	t_1	t_2	t_3
Opening stock	100	600	400
Production	1000	1000	1000
Sales	500	1200	1300
Closing stock	600	400	100

(5 marks)

(Note that all the data in (i)–(iii) are volumes, not values.)

(b) Write a short comparative evaluation of variable and absorption costing systems for management accounting purposes, paying particular attention to profit measurement, and using your answer to (a) to illustrate your arguments if you wish.

(10 marks)
ICAEW Management Accounting



PART 3

Information for Decision-making

9 Cost–volume–profit analysis

10 Cost estimation and cost behaviour

11 Measuring relevant costs and revenues for decision-making

12 The application of linear programming to management accounting

13 Activity-based costing

14 Decision-making under conditions of risk and uncertainty

15 Capital investment decisions

The main objective of this Part, which contains seven chapters, is to consider the provision of financial information that will help managers to make better decisions. Chapters 9–14 are concerned mainly with short-term decisions based on the environment of today, and the physical, human and financial resources that are presently available to a firm; these decisions are determined to a considerable extent by the quality of the firm's long-term decisions. An important distinction between the long-term and short-term decisions is that the former cannot easily be reversed whereas the latter can often be changed. The actions that follow short-term decisions are frequently repeated, and it is possible for different actions to be taken in the future. For example, the setting of a particular selling price or product mix can often be changed fairly quickly. With regard to long-term decisions, such as capital investment, which involves, for example, the purchase of new plant and machinery, it is not easy to change a decision in the short term. Resources may only be available for major investments in plant and machinery at lengthy intervals, and it is unlikely that plant replacement decisions will be repeated in the short term.

Chapters 9–14 concentrate mainly on how accounting information can be applied to different forms of short-term decisions. Chapter 9 focuses on what will happen to the financial results if a specific level of activity or volume fluctuates. This information is required for making optimal short-term output decisions. Chapter 10 examines how

cost behaviour patterns can be determined for cost–volume–profit analysis and decision-making and Chapter 11 examines how costs and revenues should be measured for a range of non-routine short-term and long-term decisions. Chapter 12 examines how linear programming can be used to provide information for short-term decisions and Chapter 13 focuses on an alternative approach for measuring resources consumed by cost objects. This approach is called activity-based costing. Chapters 9–13 assume a world of certainty, whereas Chapter 14 introduces methods of incorporating uncertainty into the analysis, and various topics covered in Chapters 9–13 are re-examined under conditions of uncertainty. The final chapter in this part is concerned with long-term decisions. Chapter 15 looks at the techniques that are used for evaluating capital investment decisions, and introduces the concept of the time value of money.



Cost–volume–profit analysis

9

In the previous chapters we have considered how costs should be extracted from the cost system database for inventory valuation and profit measurement, and we have stressed that costs should be extracted in a different way for decision-making and cost control. In the next seven chapters we shall look at the presentation of financial information for decision-making. We begin by considering how management accounting information can be of assistance in providing answers to questions about the consequences of following particular courses of action. Such questions might include 'How many units must be sold to break-even?' 'What would be the effect on profits if we reduce our selling price and sell more units?' 'What sales volume is required to meet the additional fixed charges arising from an advertising campaign?' 'Should we pay our sales people on the basis of a salary only, or on the basis of a commission only, or by a combination of the two?' These and other questions can be answered using cost–volume–profit (CVP) analysis.

This is a systematic method of examining the relationship between changes in activity (i.e. output) and changes in total sales revenue, expenses and net profit. As a model of these relationships CVP analysis simplifies the real-world conditions that a firm will face. Like most models, which are abstractions from reality, CVP analysis is subject to a

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- describe the differences between the accountant's and the economist's model of cost–volume–profit analysis;
- justify the use of linear cost and revenue functions in the accountant's model;
- apply the mathematical approach to answer questions similar to those listed in Example 9.1;
- construct break-even, contribution and profit–volume graphs;
- identify and explain the assumptions on which cost–volume–profit analysis is based;
- apply cost–volume–profit analysis in a multi-product setting.

number of underlying assumptions and limitations, which will be discussed later in this chapter; nevertheless, it is a powerful tool for decision-making in certain situations.

The objective of CVP analysis is to establish what will happen to the financial results if a specified level of activity or volume fluctuates. This information is vital to management, since one of the most important variables influencing total sales revenue, total costs and profits is output or volume. For this reason output is given special attention, since knowledge of this relationship will enable management to identify the critical output levels, such as the level at which neither a profit nor a loss will occur (i.e. the break-even point).

CVP analysis is based on the relationship between volume and sales revenue, costs and profit in the short run, the short run normally being a period of one year, or less, in which the output of a firm is restricted to that available from the current operating capacity. In the short run, some inputs can be increased, but others cannot. For example, additional supplies of materials and unskilled labour may be obtained at short notice, but it takes time to expand the capacity of plant and machinery. Thus output is limited in the short run because plant facilities cannot be expanded. It also takes time to reduce capacity, and therefore in the short run a firm must operate on a relatively constant stock of production resources. Furthermore, most of the costs and prices of a firm's products will have already been determined, and the major area of uncertainty will be sales volume. Short-run profitability will therefore be most sensitive to sales volume. CVP analysis thus highlights the effects of changes in sales volume on the level of profits in the short run.

The theoretical relationship between total sales revenue, costs and profits with volume has been developed by economists. In order to provide a theoretical basis for examining the accountant's approach to CVP analysis this chapter begins by describing the economist's model of CVP analysis.

The economist's model

An economist's model of CVP behaviour is presented in Figure 9.1. You will see that the total-revenue line is assumed to be curvilinear, which indicates that the firm is only able to sell increasing quantities of output by reducing the selling price per unit; thus the total revenue line does not increase proportionately with output. To increase the quantity of sales, it is necessary to reduce the unit selling price, which results in the total revenue line rising less steeply, and eventually beginning to decline. This is because the adverse effect of price reductions outweighs the benefits of increased sales volume.

The total cost line AD shows that, between points A and B, total costs rise steeply at first as the firm operates at the lower levels of the volume range. This reflects the difficulties of efficiently operating a plant designed for much larger volume levels. Between points B and C, the total cost line begins to level out and rise less steeply because the firm is now able to operate the plant within the efficient operating range and can take advantage of specialization of labour, and smooth production schedules. In the upper portion of the volume range the total cost line between points C and D rises more and more steeply as the cost per unit increases. This is because the output per direct labour hour declines when the plant is operated beyond the activity level for which it was designed: bottlenecks develop, production schedules become more complex, and plant breakdowns begin to occur. The overall effect is that the cost per unit of output increases and causes the total cost line to rise steeply.

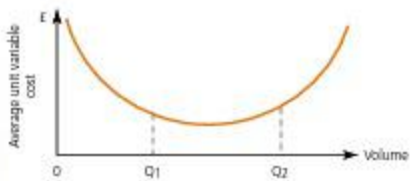
The dashed horizontal line from point A represents the cost of providing the basic operating capacity, and is the economist's interpretation of the total fixed costs of the firm. Note also from Figure 9.1 that the shape of the total revenue line is such that it crosses the total cost line at two points. In other words, there are two output levels at which the total costs are equal to the total revenues; or more simply, there are two break-even points.

It is the shape of the variable cost function in the economist's model that has the most significant influence on the total cost function; this is illustrated in Figure 9.2. The economist assumes that the average *unit* variable cost declines initially, reflecting the fact that, as output expands, a firm is able to obtain bulk discounts on the purchase of raw materials and can benefit from the division of labour; this results in the labour cost per unit being reduced. The economist refers to this situation as **increasing returns to scale**. The fact that *unit* variable cost is higher at lower levels of activity causes the total cost line between points A and B in Figure 9.1 to rise steeply. From Figure 9.2 you can see that the *unit* variable cost levels out between output levels Q_1 and Q_2 and then gradually begins to rise. This is because the firm is operating at its most efficient output level, and further economies of scale are not possible in the short term. However, beyond output level Q_2 the plant is being operated at a higher level than that for which it was intended, and bottlenecks and plant breakdowns occur. The effect of this is that output per direct labour hour declines, and causes the variable cost per unit to increase. The economist describes this situation as **decreasing returns to scale**.

FIGURE 9.1 *Economist's cost–volume graph*



FIGURE 9.2 *Economist's variable cost function*



It is the shape of the variable cost function that causes the total cost line to behave in the manner indicated in Figure 9.1. Between points B and C, the total cost line rises less steeply, indicating that the firm is operating in the range where unit variable cost is at its lowest. Between points C and D, the total cost line rises more steeply, since the variable cost per unit is increasing owing to decreasing returns to scale.

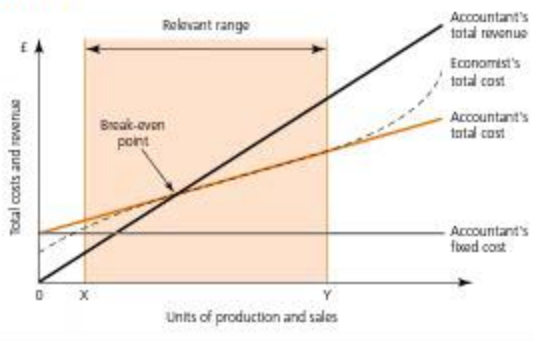
The accountant's cost–volume–profit model

The diagram for the accountant's model is presented in Figure 9.3. Note that the dashed line represents the economist's total cost function, which enables a comparison to be made with the accountant's total cost function. The accountant's diagram assumes a variable cost and a selling price that are constant per unit; this results in a linear relationship (i.e. a straight line) for total revenue and total cost as volume changes. The effect is that there is only one **break-even point** in the diagram, and the profit area widens as volume increases. The most profitable output is therefore at maximum practical capacity. Clearly, the economist's model appears to be more realistic, since it assumes that the total cost curve is non-linear.

Relevant range

How can we justify the accountant's assumption of linear cost and linear revenue functions? The answer is that the accountants' diagram is not intended to provide an accurate representation of total cost and total revenue throughout all ranges of output. The objective is to represent the behaviour of total cost and revenue over the range of output at which a firm expects to be operating within a short-term planning horizon. This range of output is represented by the output range between points X and Y in Figure 9.3. The term **relevant range** is used to refer to the output range at which the firm expects to be operating within a short-term planning horizon. This relevant range also broadly represents the output levels which the firm has had experience of operating in the past and for which cost information is available.

FIGURE 9.3 *Accountant's cost–volume–profit diagram*



You can see from Figure 9.3 that, between points X and Y, the shape of the accountant's total cost line is very similar to that of the economist's. This is because the total cost line is only intended to provide a good approximation within the relevant range. Within this range, the accountant assumes that the variable cost per unit is the same throughout the entire range of output, and the total cost line is therefore linear. Note that the cost function is approximately linear within this range. It would be unwise, however, to make this assumption for production levels outside the relevant range. It would be more appropriate if the accountant's total cost line was presented for the relevant range of output only, and not extended to the vertical axis or to the output levels beyond Y in Figure 9.3.

Fixed cost function

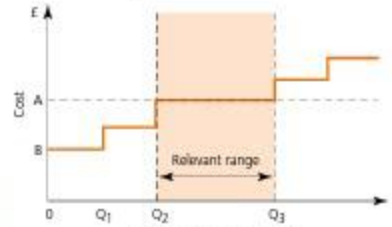
Note also that the accountant's fixed cost function in Figure 9.3 meets the vertical axis at a different point to that at which the economist's total cost line meets the vertical axis. The reason for this can be explained from Figure 9.4. The fixed cost level of 0A may be applicable to, say, activity level Q_2 to Q_3, but if there were to be a prolonged economic recession then output might fall below Q_1, and this could result in redundancies and shutdowns. Therefore fixed costs may be reduced to 0B if there is a prolonged and a significant decline in sales demand. Alternatively, additional fixed costs will be incurred if long-term sales volume is expected to be greater than Q_3. Over a longer-term time horizon, the fixed cost line will consist of a series of step functions rather than the horizontal straight line depicted in Figure 9.3. However, since within its short-term planning horizon the firm expects to be operating between output levels Q_2 and Q_3, it will be committed, in the short term, to fixed costs of 0A; but you should remember that if there was a prolonged economic recession then in the longer term fixed costs may be reduced to 0B.

The fixed cost line for output levels below Q_1 (i.e. 0B) represents the cost of providing the basic operating capacity, and this line is the equivalent to the point where the economist's total cost line meets the vertical axis in Figure 9.3. Because the accountant assumes that in the short term the firm will operate in the relevant range between Q_2 and Q_3, the accountant's fixed cost line 0A in Figure 9.4 represents the fixed costs for the relevant output range only, which the firm is committed to in the current period and does not represent the fixed costs that would be incurred at the extreme levels of output beyond the shaded area in Figure 9.4.

Total revenue function

Let us now compare the total revenue line for the accountant and the economist. We have seen that the accountant assumes that selling price is constant over the relevant range of output, and therefore the total revenue line is a straight line. The accountant's assumption about the revenue line is a realistic one in those firms that operate in industries where selling prices tend to be fixed in the short term. A further factor reinforcing the assumption of a fixed selling price is that competition may take the form of non-price rather than price competition. Moreover, beyond the relevant range, increases in output may only be possible by offering substantial reductions in price. As it is not the intention of firms to operate outside the relevant range, the accountant makes no attempt to produce accurate revenue functions outside this range. It might be more meaningful in Figure 9.3 if the total revenue line was presented for output levels X and Y within the relevant range, instead of being extended to the left and right of these points.

FIGURE 9.4 *Accountant's fixed costs*



A mathematical approach to cost–volume–profit analysis

Instead of using a diagram to present CVP information, we can use mathematical relationships. The mathematical approach is a quicker and more flexible method of producing the appropriate information than the graphical approach, and is a particularly appropriate form of input to a computer financial model.

When developing a mathematical formula for producing CVP information, you should note that one is assuming that selling price and costs remain constant per unit of output. Such an assumption may be valid for unit selling price and variable cost, but remember that in Chapter 2 we noted that in the short run fixed costs are a constant *total* amount whereas *unit* cost changes with output levels. As a result, profit per *unit* also changes with volume. For example, if fixed costs are £10 000 for a period and output is 10 000 units, the fixed cost will be £1 per unit. Alternatively, if output is 5000 units, the fixed cost will be £2 per unit. Profit per unit will not therefore be constant over varying output levels and it is incorrect to unitize fixed costs for CVP decisions.

We can develop a mathematical formula from the following relationship:

$$\text{net profit} = (\text{units sold} \times \text{unit selling price}) - [(\text{units sold} \times \text{unit variable cost}) + \text{total fixed costs}]$$

The following symbols can be used to represent the various items in the above equation:

NP = net profit
x = units sold
P = selling price
b = unit variable cost
a = total fixed costs

The equation can now be expressed in mathematical terms as

$$NP = Px - (a + bx) \tag{9.1}$$

You should now refer to Example 9.1. This example will be used to illustrate the application of the mathematical approach to CVP analysis.

EXAMPLE 9.1

Lee Enterprises operate in the leisure and entertainment industry and one of its activities is to promote concerts at locations throughout the world. The company is examining the viability of a concert in Singapore. Estimated fixed costs are £60 000. These include the fees paid to performers, the hire of the venue and advertising costs. Variable costs consist of the cost of a pre-packed buffet which will be provided by a firm of caterers at a price, which is currently being negotiated, but it is likely to be in the region of £10 per ticket sold. The proposed price for the sale of a ticket is £20. The management of Lee have requested the following information:

1. The number of tickets that must be sold to break-even (that is, the point at which there is neither a profit or loss).
2. How many tickets must be sold to earn £30 000 target profit?
3. What profit would result if 8000 tickets were sold?
4. What selling price would have to be charged to give a profit of £30 000 on sales of 8000 tickets, fixed costs of £60 000 and variable costs of £10 per ticket?
5. How many additional tickets must be sold to cover the extra cost of television advertising of £8000?

Let us now provide the information requested in Example 9.1.

1 Break-even point in units (i.e. number of tickets sold)

Since $NP = Px - (a + bx)$, the break-even point is at a level of output (x) where

$$a + bx = Px - NP$$

Substituting the information in Example 9.1, we have

$$60\,000 + 10x = 20x - 0$$
$$60\,000 = 10x$$

and so $x = 6000$ tickets (or £120 000 total sales at £20 per ticket).

An alternative method, called the **contribution margin** approach, can also be used. Contribution margin is equal to sales minus variable expenses. Because the variable cost per unit and the selling price per unit are assumed to be constant the contribution margin per unit is also assumed to be constant. In Example 9.1 note that each ticket sold generates a contribution of £10, which is available to cover fixed costs and, after they are covered, to contribute to profit. When we have obtained sufficient total contribution to cover fixed costs, the break-even point is achieved, and the alternative formula is

$$\text{break-even point in units} = \frac{\text{fixed costs}}{\text{contribution per unit}}$$

The contribution margin approach can be related to the mathematical formula approach. Consider the penultimate line of the formula approach; it reads

$$£60\,000 = 10x$$

and so

$$x = \frac{£60\,000}{£10}$$

giving the contribution margin formula

$$\frac{\text{fixed costs}}{\text{contribution per unit}}$$

The contribution margin approach is therefore a restatement of the mathematical formula, and either technique can be used; it is a matter of personal preference.

2 Units to be sold to obtain a £30 000 profit

Using the equation $NP = Px - (a + bx)$ and substituting the information in Example 9.1, we have

$$£30\,000 = £20x - (£60\,000 + £10x)$$
$$£90\,000 = £10x$$

and so

$$x = 9000 \text{ tickets}$$

If we apply the contribution margin approach and wish to achieve the desired profit, we must obtain sufficient contribution to cover the fixed costs (i.e. the break-even point) plus a further contribution to cover the target profit. Hence we simply add the target profit to the fixed costs so that the equation using the contribution margin approach is

$$\text{units sold for target profit} = \frac{\text{fixed costs} + \text{target profit}}{\text{contribution per unit}}$$

This is merely a restatement of the penultimate line of the mathematical formula, which reads

$$£90\,000 = £10x$$

and so

$$x = \frac{£90\,000}{£10}$$

3 Profit from the sale of 8000 tickets

Substituting in the equation $NP = Px - (a + bx)$, we have

$$NP = £20 \times 8000 - (£60\,000 + £10 \times 8000)$$
$$= £160\,000 - (£60\,000 + £80\,000)$$

and so

$$NP = £20\,000$$

Alternatively, we can apply the contribution margin approach. The total contribution for the sale of 8000 tickets is £80 000 (8000 × £10). To ascertain the profit we deduct the fixed costs of £60 000 giving a net profit of £20 000.

Let us now assume that we wish to ascertain the impact on profit if a further 1000 tickets are sold so that sales volume increases from 8000 to 9000 tickets. Assuming that fixed costs remain unchanged, the impact on a firm's profits resulting from a change in the number of units sold can be determined by multiplying the unit contribution margin by the change in units sold. Therefore the increase in profits will be £10 000 (1000 units times a unit contribution margin of £10).

4 Selling price to be charged to show a profit of £30 000 on sales of 8000 tickets

Applying the formula for net profit (i.e. Equation 9.1)

$$£30\,000 = 8000P - (60\,000 + (£10 \times 8000))$$
$$= 8000P - £140\,000$$

giving $8000P = £170\,000$

and $P = £21.25$ (i.e. an increase of £1.25 per ticket)

An alternative approach is to determine the total required revenue to obtain a profit of £30 000. This is £170 000 which is derived from the sum of the fixed costs (£60 000), variable costs (8000 × £10) and the target profit (£30 000). Dividing the required sales revenues of £170 000 by the sales volume (8000 tickets) gives a selling price of £21.25.

5 Additional sales volume to meet £8000 additional fixed advertising charges

The contribution per unit is £10 and fixed costs will increase by £8000. Therefore an extra 800 tickets must be sold to cover the additional fixed costs of £8000.

The profit–volume ratio

The **profit–volume ratio** (also known as the **contribution margin ratio**) is the contribution divided by sales. It represents the proportion of each £1 sales available to cover fixed costs and provide for profit. In Example 9.1 the contribution is £10 per unit and the selling price is £20 per unit; the profit–volume ratio is 0.5. This means that for each £1 sale a contribution of £0.50 is earned. Because we assume that selling price and contribution per unit are constant, the profit–volume ratio is also assumed to be constant. Therefore the profit–volume ratio can be computed using either unit figures or total figures. Given an estimate of total sales revenue, it is possible to use the profit–volume ratio to estimate total contribution. For example, if total sales revenue is estimated to be £200 000, the total contribution will be £100 000 (£200 000 × 0.5). To calculate the profit, we deduct fixed costs of £60 000; thus a profit of £40 000 will be obtained from total sales revenue of £200 000.

Expressing the above computations in mathematical terms:

$$\text{NP} = (\text{Sales revenue} \times \text{PV ratio}) - \text{Fixed costs}$$
$$\text{NP} + \text{Fixed costs} = \text{Sales revenue} \times \text{PV ratio}$$

Therefore the break-even sales revenue (where NP = 0) = Fixed costs/PV ratio.

Relevant range

It is vital to remember that, as with the mathematical approach, the formulae method can only be used for decisions that result in outcomes within the relevant range. Outside this range the unit selling price and the variable cost are no longer deemed to be constant per unit, and any results obtained from the formulae that fall outside the relevant range will be incorrect. The concept of the relevant range is more appropriate for production settings but it can apply within non-production settings. Returning to Lee Enterprises in Example 9.1, let us assume that the caterers' charges will be higher per ticket if ticket sales are below 4000 but lower if sales exceed 12 000 tickets. Thus, the £10 variable cost relates only to a sales volume within a range of 4000–12 000 tickets. Outside this range other costs apply. Also the number of seats made available at the venue is flexible and the hire cost will be reduced for sales of less than 4000 tickets and increased for sales beyond 12 000 tickets. In other words, we will assume that the relevant range is a sales volume of 4000–12 000 tickets and outside this range the results of our CVP analysis do not apply.

Margin of safety

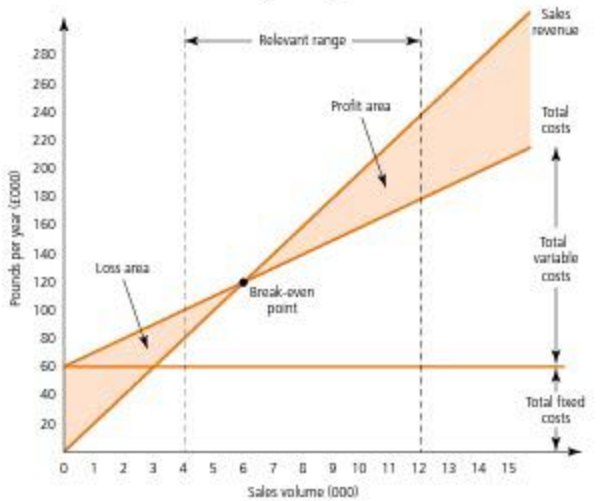
The **margin of safety** indicates by how much sales may decrease before a loss occurs. Using Example 9.1, where unit selling price and variable cost were £20 and £10 respectively and fixed costs were £60 000, we noted that the break-even point was 6000 tickets or £120 000 sales value. If sales are expected to be 8000 tickets or £160 000, the margin of safety will be 2000 tickets or £40 000. Alternatively, we can express the margin of safety in a percentage form based on the following ratio:

$$\text{percentage margin of safety} = \frac{\text{expected sales} - \text{break-even sales}}{\text{expected sales}}$$
$$= \frac{£160\,000 - £120\,000}{£160\,000} = 25\%$$

Constructing the break-even chart

Managers may obtain a clearer understanding of CVP behaviour if the information is presented in graphical format. Using the data in Example 9.1, we can construct the **break-even chart** for Lee Enterprises (Figure 9.5). In constructing the graph, the fixed costs are plotted as a single horizontal line at the £60 000 level. Variable costs at the rate of £10 per unit of volume are added to the fixed costs to enable the total cost line to be plotted. Two points are required to insert the total cost line. At zero sales volume total cost will be equal to the fixed costs of £60 000. At 12 000 units sales volume total costs will be £180 000 consisting of £120 000 variable cost plus £60 000 fixed costs. The

FIGURE 9.5 *Break-even chart for Example 9.1*



total revenue line is plotted at the rate of £20 per unit of volume. The constraints of the relevant range consisting of two vertical lines are then added to the graph: beyond these lines we have little assurance that the CVP relationships are valid.

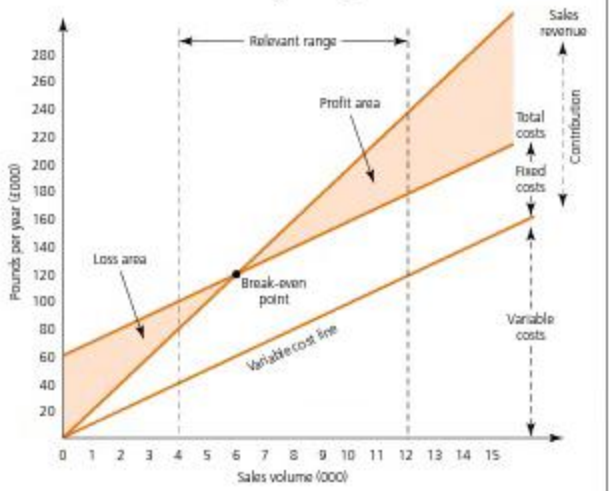
The point at which the total sales revenue line cuts the total cost line is the point where the concert makes neither a profit nor a loss. This is the break-even point and is 6000 tickets or £120 000 total sales revenue. The distance between the total sales revenue line and the total cost line at a volume below the break-even point represents losses that will occur for various sales levels below 6000 tickets. Similarly, if the company operates at a sales volume above the break-even point, the difference between the total revenue and the total cost lines represents the profit that results from sales levels above 6000 tickets.

Alternative presentation of cost–volume–profit analysis

Contribution graph

In Figure 9.5 the fixed cost line is drawn parallel to the horizontal axis, and the variable cost is the difference between the total cost line and the fixed cost line. An alternative to Figure 9.5 for the data contained in Example 9.1 is illustrated in Figure 9.6. This alternative presentation is called a **contribution graph**. In Figure 9.6 the variable cost line is drawn first at £10 per unit of volume. The fixed costs are represented by the difference

FIGURE 9.6 *Contribution chart for Example 9.1*

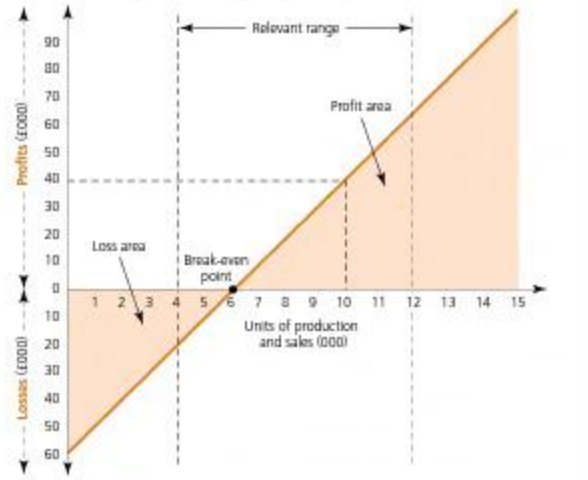


between the total cost line and the variable cost line. Because fixed costs are assumed to be a constant sum throughout the entire output range, a constant sum of £60 000 for fixed costs is added to the variable cost line, which results in the total cost line being drawn parallel to the variable cost line. The advantage of this form of presentation is that the total contribution is emphasized in the graph, and is represented by the difference between the total sales revenue line and the total variable cost line.

Profit–volume graph

The break-even and contribution charts do not highlight the profit or loss at different volume levels. To ascertain the profit or loss figures from a break-even chart, it is necessary to determine the difference between the total-cost and total-revenue lines. The **profit–volume graph** is a more convenient method of showing the impact of changes in volume on profit. Such a graph is illustrated in Figure 9.7. The horizontal axis represents the various levels of sales volume, and the profits and losses for the period are recorded on the vertical scale. You will see from Figure 9.7 that profits or losses are plotted for each of the various sales levels, and these points are connected by a profit line. Two points are required to plot the profit line. When units sold are zero a loss equal to the amount of fixed costs (£60 000) will be reported. At the break-even point (zero profits) sales volume is 6000 units. Therefore the break-even point is plotted at the point where the profit line intersects the horizontal line at a sales volume of 6000 tickets. The profit line is drawn between the two points. With each unit sold, a contribution of £10 is obtained towards the fixed costs, and the break-even

FIGURE 9.7 *Profit–volume graph for Example 9.1*



point is at 6000 tickets, when the total contribution exactly equals the total of the fixed costs. With each additional unit sold beyond 6000 tickets, a surplus of £10 per ticket is obtained. If 10 000 tickets are sold, the profit will be £40 000 (4000 tickets at £10 contribution). You can see this relationship between sales and profit at 10 000 tickets from the dotted lines in Figure 9.7.

Multi-product cost–volume–profit analysis

Our analysis so far has assumed a single-product setting. However, most firms produce and sell many products or services. In this section we shall consider how we can adapt the analysis used for a single-product setting to a multi-product setting. Consider the situation presented in Example 9.2. You will see that the company sells two products so that there are two unit contribution margins. We can apply the same approach as that used for a single product if all of the fixed costs are directly attributable to products (i.e. there are no common fixed costs) or our analysis focuses only on the contribution to common fixed costs, rather than operating profit. We simply apply the analysis separately to each product as follows:

De-luxe washing machine break-even point
= Direct fixed costs (£90 000)/Unit contribution (£150)
= 600 units

EXAMPLE 9.2

The Super Bright Company sells two types of washing machines – a de-luxe model and a standard model. The financial controller has prepared the following information based on the sales forecast for the period:

Sales volume (units)	De-luxe machine 1200 (£)	Standard machine 600 (£)	Total (£)
Unit selling price	300	200	
Unit variable cost	150	110	
Unit contribution	150	90	
Total sales revenues	360 000	120 000	480 000
Less: Total variable cost	180 000	66 000	246 000
Contribution to direct and common fixed costs[a]	180 000	54 000	234 000
Less: Direct avoidable fixed costs	90 000	27 000	117 000
Contribution to common fixed costs[a]	90 000	27 000	117 000
Less common (indirect) fixed costs			39 000
Operating profit			78 000

The common fixed costs relate to the costs of common facilities and can only be avoided if neither of the products is sold. The managing director is concerned that sales may be less than forecast and has requested information relating to the break-even point for the activities for the period.

Note

[a]Contribution was defined earlier in this chapter as sales less variable costs. Where fixed costs are divided into direct and common (indirect) fixed costs it is possible to identify two separate contribution categories. The first is described as contribution to direct and common fixed costs and this is identical to the conventional definition, being equivalent to sales less variable costs. The second is after a further deduction of direct fixed costs and is described as 'Contribution to common or indirect fixed costs'.

Standard washing machine break-even point
= Direct fixed costs (£27 000)/Unit contribution (£90)
= 300 units

However, selling 600 de-luxe and 300 standard washing machines will generate a contribution that only covers direct fixed costs; the common fixed costs will not be covered. A loss equal to the common fixed costs will be reported. The break-even point for the firm as a whole has not been ascertained.

You may think that the break-even point for the firm as a whole can be derived if we allocate the common fixed costs to each individual product but this approach is inappropriate because the allocation will be arbitrary. The common fixed costs cannot be specifically identified with either of the products since they can only be avoided if *both* products are not sold. The solution to our problem is to convert the sales volume measure of the individual products into standard batches of products based on the planned sales mix. You will from see from Example 9.2 that Super Bright plans to sell 1200 de-luxe and 600 standard machines giving a sales mix of 1200:600. Reducing this



The impact of Volkswagen's high break-even point on profitability

In the early 1990s Volkswagen AG of Germany reported a large continuing decline in earnings even though in 1992 it sold a record 3.5 million vehicles world-wide. One of the reasons for the declining profitability was that its break-even point was above 90%. Consequently, sales had to exceed 90% capacity before profits were reported. The company had to run its factory on overtime just to make a small profit. In contrast, European competitors already had break-even points below 70% of capacity. To overcome this problem, steps were taken to reduce fixed capacity costs that would enable it in the short-term to head rapidly to a break-even below 90%.

Source: Aeppel, T. (1993), 'VW Chief declares a crisis and prescribes bold action,' *The Wall Street Journal*, 1 April, p.B4.

sales mix to the smallest whole number gives a mix of 2:1. In other words, for the sale of every two deluxe machines one standard machine is expected to be sold. We therefore define our standard batch of products as comprising two de-luxe and one standard machine giving a contribution of £390 per batch (two de-luxe machines at a contribution of £150 per unit sold plus one standard machine at a contribution of £90).

The break-even point in standard batches can be calculated by using the same break-even equation that we used for a single product so that:

$$\text{Break-even number of batches} = \frac{\text{Total fixed costs (£156 000)}}{\text{Contribution margin per batch (£390)}} = 400 \text{ batches}$$

The sales mix used to define a standard batch (2:1) can be now be used to convert the break-even point (measured in standard batches) into a break-even point expressed in terms of the required combination of individual products sold. Thus, 800 de-luxe machines (2 × 400) and 400 (1 × 400) standard machines must be sold to break even. The following profit statement verifies this outcome:

Units sold	De-luxe machine 800 (£)	Standard machine 400 (£)	Total (£)
Unit contribution margin	150	90	
Contribution to direct and common fixed costs	120 000	36 000	156 000
Less: Direct fixed costs	90 000	27 000	117 000
Contribution to common fixed costs	30 000	9 000	39 000
Less: Common fixed costs			39 000
Operating profit			0

Let us now assume that the actual sales volume for the period was 1200 units, the same total volume as the break-even volume, but consisting of a sales mix of 600 units of each machine. Thus, the actual sales mix is 1:1 compared with a planned sales mix of 2:1. The total contribution to direct and common fixed costs will be £144 000 ([150 × 600] + [£90 × 600]) and a loss of £12 000 (£144 000 contribution

– £156 000 total fixed costs) will occur. It should now be apparent to you that the break-even point (or the sales volumes required to achieve a target profit) is not a unique number: it varies depending upon the composition of the sales mix. Because the actual sales mix differs from the planned sales mix, the sales mix used to define a standard batch has changed from 2:1 to 1:1 so that the contribution per batch changes from £390 to £240 ([1 × £150] + [1 × £90]). Therefore the revised break-even point will be 650 batches (£156 000 total fixed costs/£240 contribution per batch) which converts to a sales volume of 650 units of each machine based on a 1:1 sales mix. Generally, an increase in the proportion of sales of higher contribution margin products will decrease the break-even point whereas increases in sales of the lower margin products will increase the break-even point.

Cost–volume–profit analysis assumptions

It is essential that anyone preparing or interpreting CVP information is aware of the underlying assumptions on which the information has been prepared. If these assumptions are not recognized, serious errors may result and incorrect conclusions may be drawn from the analysis. We shall now consider these important assumptions. They are as follows:

1. All other variables remain constant.
2. A single product or constant sales mix.
3. Total costs and total revenue are linear functions of output.
4. Profits are calculated on a variable costing basis.
5. The analysis applies to the relevant range only.
6. Costs can be accurately divided into their fixed and variable elements.
7. The analysis applies only to a short-term time horizon.
8. Complexity-related fixed costs do not change.

1 All other variables remain constant

It has been assumed that all variables other than the particular one under consideration have remained constant throughout the analysis. In other words, it is assumed that volume is the only factor that will cause costs and revenues to change. However, changes in other variables such as production efficiency, sales mix, price levels and production methods can have an important influence on sales revenue and costs. If significant changes in these other variables occur the CVP analysis presentation will be incorrect.

2 Single product or constant sales mix

CVP analysis assumes that either a single product is sold or, if a range of products is sold, that sales will be in accordance with a predetermined sales mix. When a predetermined sales mix is used, it can be depicted in the CVP analysis by measuring sales volume using standard batch sizes based on a planned sales mix. Any CVP analysis must be interpreted carefully if the initial product mix assumptions do not hold.

3 Total costs and total revenue are linear functions of output

The analysis assumes that unit variable cost and selling price are constant. This assumption is only likely to be valid within the relevant range of production described on page 243.

4 Profits are calculated on a variable costing basis

The analysis assumes that the fixed costs incurred during the period are charged as an expense for that period. Therefore variable-costing profit calculations are assumed. If absorption-costing profit calculations are used, it is necessary to assume that production is equal to sales for the analysis to predict absorption costing profits. For the application of CVP analysis with an absorption costing system you should refer to Drury (2004, Ch. 8).

5 Analysis applies to relevant range only

Earlier in this chapter we noted that CVP analysis is appropriate only for decisions taken within the relevant production range, and that it is incorrect to project cost and revenue figures beyond the relevant range.

6 Costs can be accurately divided into their fixed and variable elements

CVP analysis assumes that costs can be accurately analysed into their fixed and variable elements. The separation of semi-variable costs into their fixed and variable elements is extremely difficult in practice. Nevertheless a reasonably accurate analysis is necessary if CVP analysis is to provide relevant information for decision-making.

7 The analysis applies only to a short-term time horizon

At the beginning of this chapter we noted that CVP analysis is based on the relationship between volume and sales revenue, costs and profits in the short-term, the short-term being typically a period of one year. In the short-term the costs of providing a firm's operating capacity, such as property taxes and the salaries of senior managers, are likely to be fixed in relation to changes in activity. Decisions on the firm's intended future potential level of operating capacity will determine the amount of capacity costs to be incurred. These decisions will have been made previously as part of the long-term planning process. Once these decisions have been made, they cannot easily be reversed in the short-term. It takes time to significantly expand the capacity of plant and machinery or reduce capacity. Furthermore, plant investment and abandonment decisions should not be based on short-term fluctuations in demand within a particular year. Instead, they should be reviewed periodically as part of the long-term planning process and decisions based on predictions of long-run demand over several years. Thus capacity costs will tend to be fixed in relation to changes of activity within short-term

periods such as one year. However, over long-term periods significant changes in volume or product complexity will cause fixed costs to change.

It is therefore assumed that in the short term some costs will be fixed and unaffected by changes in volume whereas other (variable) costs will vary with changes in volume. In the short-run volume is the most important variable influencing total revenue, costs and profit. For this reason volume is given special attention in the form of CVP analysis. You should note, however, that in the long-term other variables, besides volume, will cause costs to change. Therefore, the long-term analysis should incorporate other variables, besides volume, and recognize that fixed costs will increase or decrease in steps in response to changes in the explanatory variables.

8 Complexity-related fixed costs do not change

CVP analysis assumes that **complexity-related costs** will remain unchanged. Cooper and Kaplan (1987) illustrate how complexity-related fixed costs can increase as a result of changes in the range of items produced, even though volume remains unchanged. They illustrate the relationship with an example of two identical plants. One plant produces one million units of product A. The second plant produces 100 000 units of A and 900 000 similar units of 199 similar products. The first plant has a simple production environment and requires limited manufacturing support facilities. Set-ups, expediting, inventory movements and schedule activities are minimal. The other plant has a much more complex production management environment. The 200 products must be scheduled through the plant, and this requires frequent set-ups, inventory movements, purchase receipts and inspections. To handle this complexity, the support departments' fixed costs must be larger.

Cooper and Kaplan use the above example to illustrate that many so-called fixed costs vary not with the volume of items manufactured but with the range of items produced (i.e. the complexity of the production process). Complexity-related costs do not normally vary significantly in the short-term with the volume of production. If a change in volume does not alter the range of products then it is likely that complexity-related fixed costs will not alter, but if volume stays constant and the range of items produced changes then support department fixed costs will eventually change because of the increase or decrease to product complexity.

CVP analysis assumptions will be violated if a firm seeks to enhance profitability by product proliferation: that is, by introducing new variants of products based on short-term contribution margins. The CVP analysis will show that profits will increase as sales volume increases and fixed costs remain constant in the short-term. The increased product diversity, however, will cause complexity-related fixed costs to increase in future periods, and there is a danger that long-term profits may decline as a result of product proliferation. The CVP analysis incorporates the fixed costs required to handle the diversity and complexity within the current product range, but the costs will remain fixed only if diversity and complexity are not increased further. Thus CVP analysis will not capture the changes in complexity-related costs arising from changes in the range of items produced.

Cost–volume–profit analysis and computer applications

The output from a CVP model is only as good as the input. The analysis will include assumptions about sales mix, production efficiency, price levels, total fixed costs,

variable costs and selling price per unit. Obviously, estimates regarding these variables will be subject to varying degrees of uncertainty.

Sensitivity analysis is one approach for coping with changes in the values of the variables. Sensitivity analysis focuses on how a result will be changed if the original estimates or the underlying assumptions change. With regard to CVP analysis, sensitivity analysis answers questions such as the following:

1. What will the profit be if the sales mix changes from that originally predicted?
2. What will the profit be if fixed costs increase by 10% and variable costs decline by 5%?

The widespread use of spreadsheet packages has enabled management accountants to develop CVP computerized models. Managers can now consider alternative plans by keying the information into a computer, which can quickly show changes both graphically and numerically. Thus managers can study various combinations of changes in selling prices, fixed costs, variable costs and product mix, and can react quickly without waiting for formal reports from the management accountant.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Describe the differences between the accountant's and the economist's model of cost–volume–profit analysis.**

  The major differences are that the total cost and total revenue functions are curvilinear in the economist's model whereas the accountant's model assumes linear relationships. However, the accountant's model is intended to predict CVP behaviour only within the relevant range, where a firm is likely to be operating on constant returns to scale. A comparison of the two models suggested that, within the relevant range of activity, the total costs and revenue functions are fairly similar.

- **Justify the use of linear cost and revenue functions in the accountant's model.**

  Within the relevant range it is generally assumed that cost and revenue functions are approximately linear. Outside the relevant range linearity is unlikely to apply. Care is therefore required in interpreting CVP relationships outside the relevant range.

- **Apply the mathematical approach to answer questions similar to those listed in Example 9.1.**

  In Example 9.1, the break-even point was derived by dividing fixed costs by the contribution per unit. To ascertain the number of units sold to achieve a target profit the sum of the fixed costs and the target profit is divided by the contribution per unit.

- **Construct break-even, contribution and profit–volume graphs.**

  Managers may obtain a clearer understanding of CVP behaviour if the information is presented in graphical format. With the break-even chart the fixed costs are plotted as a single horizontal line. The total cost line is plotted by adding variable costs to fixed costs. The reverse situation applies with a contribution graph. The variable costs are plotted first and the fixed costs are added to variable costs to plot

the total cost line. Because fixed costs are assumed to be a constant sum throughout the output range, the total cost line is drawn parallel to the variable cost line. The break-even and contribution graphs do not highlight the profit or loss at different output levels and must be ascertained by comparing the differences between the total cost and total revenue lines. The profit–volume graph shows the impact of changes in volume on profits. The profits and losses are plotted for each of the various sales levels and these are connected by a profit line. You should refer to Figures 9.5–9.7 for an illustration of the graphs.

- **Identify and explain the assumptions on which cost–volume–profit analysis is based.**

  Cost–volume–profit analysis is based on the following assumptions: (a) all variables, other than volume, remain constant; (b) the sales mix remains constant; (c) total costs and revenues are linear functions of output; (d) profits are calculated on a variable costing basis; (e) the analysis applies only to the relevant range; (f) costs can be accurately divided into their fixed and variable elements; (g) the analysis applies only to a short-term horizon, and (h) complexity-related fixed costs do not change.

- **Apply cost–volume–profit analysis in a multi-product setting.**

  Multi-product CVP analysis requires that an assumption is made concerning the expected sales mix. The approach that is used is to convert the multi-product CVP analysis into a single product analysis based on the assumption that output consists of standard batches of the multiple products based on the expected sales mix. However, you should note that the answers change as the sales mix changes.



Key terms and concepts

break-even chart (p. 250)
break-even point (p. 243)
complexity-related costs (p. 258)
contribution graph (p. 251)
contribution margin (p. 247)
contribution margin ratio (p. 249)
decreasing returns to scale (p. 243)
increasing returns to scale (p. 243)
margin of safety (p. 250)
profit–volume graph (p. 252)
profit–volume ratio (p. 249)
relevant range (p. 243)
sensitivity analysis (p. 259)

Key examination points

Students tend to experience little difficulty in preparing break-even charts, but many cannot construct profit–volume charts. Remember that the horizontal axis represents the level of activity, while profit/losses are shown on the vertical axis. The maximum loss is at zero activity, and is equal to fixed costs. For practice on preparing a profit–volume chart you should attempt Review problem 9.24 and compare your answer with the solution. Students also experience difficulty with the following:

1. coping with multi-product situations;
2. calculating the break-even point when total sales and costs are given but no information is given on the unit costs;
3. explaining the assumptions of CVP analysis.

For multi-product situations you should base your answer on the average contribution per unit, using the approach shown in Example 9.2. Review problem 9.27 requires the computation of a break-even point in a multi-product setting. When unit costs are not given the break-even point in sales value can be calculated as follows:

$$\text{Fixed costs} \times \frac{\text{total estimated sales}}{\text{total estimated contribution}}$$

or

$$\frac{\text{Fixed costs}}{\text{profit – volume ratio}}$$

You should refer to the solutions to Review problems 9.15, 9.19 and 9.25 for an illustration of the application of the above approach.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

9.1 Provide examples of how cost–volume–profit analysis can be used for decision-making. (*p. 241*)

9.2 Distinguish between the economist's and the accountant's approach to cost–volume–profit analysis. (*pp. 242–45*)

9.3 Explain what is meant by the term 'relevant range'. (*p. 247*)

9.4 Define the term 'contribution margin'. (*p. 247*)

9.5 Define the term 'profit–volume ratio' and explain how it can be used for cost–volume–profit analysis. (*p. 249*)

9.6 Describe and distinguish between the three different approaches of presenting cost–volume–profit relationships in graphical format. (*pp. 250–53*)

9.7 Describe the assumptions underlying cost–volume–profit analysis. (*pp. 256–8*)

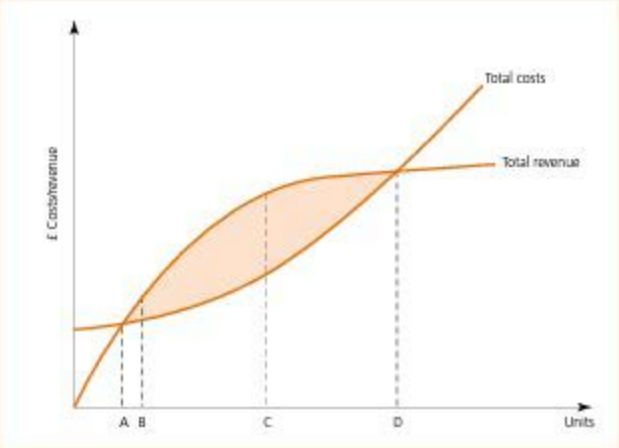
9.8 How can a company with multiple products use cost–volume–profit analysis? (*pp. 253–6*)

9.9 Explain why the break-even point changes when there is a change in sales mix. (*pp. 255–6*)

9.10 How can sensitivity analysis be used in conjunction with cost–volume–profit analysis? (*pp. 258–9*)

Review problems

9.11 Consider the following graph for total costs and total revenue:



At which point on the above graph is it most likely that profits will be maximized?

A
B
C
D

ACCA Paper 1.2 – Financial Information for Management

9.12 A company has established a budgeted sales revenue for the forthcoming period of £500 000 with an associated contribution of £275 000. Fixed production costs are £137 500 and fixed selling costs are £27 500.

What is the break-even sales revenue?

A £75 625
B £90 750
C £250 000
D £300 000

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9.13 A company wishes to make a profit of £150 000. It has fixed costs of £75 000 with a C/S ratio of 0.75 and a selling price of £10 per unit.

How many units would the company need to sell in order to achieve the required level of profit?

A 10 000 units
B 15 000 units
C 22 500 units
D 30 000 units

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9.14 A company has calculated its margin of safety as 20% on budgeted sales and budgeted sales are 5000 units per month.

What would be the budgeted fixed costs if the budgeted contribution was £25 per unit?

A £100 000
B £125 000
C £150 000
D £160 000

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9.15 H Limited manufactures and sells two products, J and K. Annual sales are expected to be in the ratio of J:1, K:3. Total annual sales are planned to be £420 000. Product J has a contribution to sales ratio of 40%, whereas that of product K is 50%. Annual fixed costs are estimated to be £120 000.

The budgeted break-even sales value (to the nearest £1000):

A £196 000
B £200 000
C £253 000
D £255 000
E cannot be determined from the above data.

CIMA Stage 2

9.16 Z plc currently sells products Aye, Bee and Cee in equal quantities and at the same selling price per unit. The contribution to sales ratio for product Aye is 40%; for product Bee it is 50% and the total is 48%. If fixed costs are unaffected by mix and are currently 20% of sales, the effect of changing the product mix to:

Aye	40%
Bee	25%
Cee	35%

is that the total contribution/total sales ratio changes to:

A 27.4%
B 45.3%
C 47.4%
D 48.4%
E 68.4%

CIMA Stage 2

9.17 E plc operates a marginal costing system. For the forthcoming year, variable costs are budgeted to be 60% of sales value and fixed costs are budgeted to be 10% of sales value.

If E plc increases its selling prices by 10%, but if fixed costs, variable costs per unit and sales volume remain unchanged, the effect on E plc's contribution would be:

A a decrease of 2%
B an increase of 5%
C an increase of 10%
D an increase of 25%
E an increase of $66\frac{2}{3}\%$

CIMA Stage 2

9.18 A manufacturer of cell phones is considering the following actions. Which of these is likely to increase the manufacturer's C/S (contribution/sales) ratio?

(i) taking advantage of quantity discounts for bulk purchases of material;
(ii) introducing training programmes designed to improve labour efficiency;
(iii) following the actions of a competitor who has cut prices substantially;
(iv) reducing exports to countries where there is intense price competition;
(v) offering retailers a lower price if they display the product more prominently.

A (ii), (iii) and (v)
B (i), (ii) and (iv)
C (i), (iii) and (iv)
D (ii), (iv) and (v)

CIMA Management Accounting Fundamentals

9.19 Z plc makes a single product which it sells for £16 per unit. Fixed costs are £76 800 per month and the product has a contribution to sales ratio of 40%.

In a period when actual sales were £224 000, Z plc's margin of safety, in units, was

A 2 000
B 6 000
C 8 000
D 12 000
E 14 000

CIMA Stage 2

9.20 The following information is required for sub-questions (a) and (b)

W Ltd makes leather purses. It has drawn up the following budget for its next financial period:

Selling price per unit	$11.60
Variable production cost per unit	$3.40
Sales commission	5% of selling price
Fixed production costs	$430 500
Fixed selling and administration costs	$198 150
Sales	90 000 units

(a) The margin of safety represents

A 5.6% of budgeted sales
B 8.3% of budgeted sales
C 11.6% of budgeted sales
D 14.8% of budgeted sales

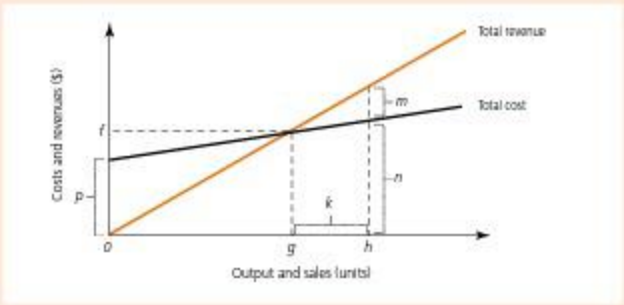
(b) The marketing manager has indicated that an increase in the selling price to $12.25 per unit would not affect the number of units sold, provided that the sales commission is increased to 8% of the selling price.

These changes will cause the break-even point (to the nearest whole number) to be

A 71 033 units B 76 016 units C 79 879 units D 87 070 units

CIMA – Management Accounting Fundamentals

9.21 The following information is required for sub-questions (a) and (b)



The company expects to sell h units in the next accounting period.

(a) The margin of safety is shown on the diagram by

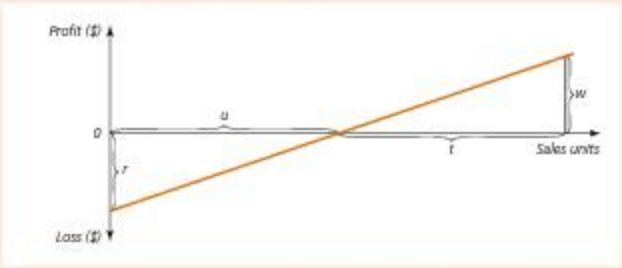
A k B m C n D p

(b) The effect of an increase in fixed costs, with all other costs and revenues remaining the same, will be

A an increase in m
B an increase in k
C an increase in f
D a reduction in p

CIMA – Management Accounting Fundamentals

9.22 The diagram shows the profit–volume chart of Z Ltd for its last accounting period. The company made a profit of $$w$ during the period.



(a) An increase in the fixed costs per period (assuming the selling price per unit and the variable cost per unit remain unchanged), will result in

(i) a reduction in r.
(ii) an increase in w.
(iii) a reduction in t.
(iv) no change in u.

(b) The following results were achieved in the last accounting period:

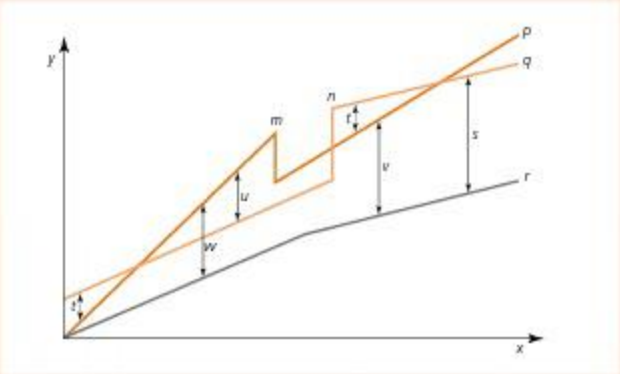
r = $50 000 w = $16 000 t = 800 units u = 2500 units

The company expects to make and sell an additional 1400 units in the next accounting period. If variable cost per unit, selling price per unit and total fixed costs remain unchanged, the effect on profit will be

(i) an increase of $10 500.
(ii) an increase of $21 210.
(iii) an increase of $28 000.
(iv) an increase of $87 500.

CIMA Management Accounting Fundamentals

9.23 A break-even chart is shown below for Windhurst Ltd.



You are required:

(i) to identify the components of the break-even chart labelled *p*, *q*, *r*, *s*, *t*, *u*, *v*, *w*, *x* and *y*;

(5 marks)

(ii) to suggest what events are represented at the values of *x* that are labelled *m* and *n* on the chart;

(3 marks)

(iii) to assess the usefulness of break-even analysis to senior management of a small company.

(7 marks)

ICAEW Management Accounting

9.24 Preparation of break-even and profit–volume graphs

ZED plc manufactures one standard product, which sells at £10. You are required to:

(a) prepare from the data given below, a break-even and profit–volume graph showing the results for the six months ending 30 April and to determine:

(i) the fixed costs;
(ii) the variable cost per unit;
(iii) the profit–volume ratio;
(iv) the break-even point;
(v) the margin of safety;

Month	Sales (units)	Profit/(loss) (£)
November	30 000	40 000
December	35 000	60 000
January	15 000	(20 000)
February	24 000	16 000
March	26 000	24 000
April	18 000	(8 000)

(b) discuss the limitations of such a graph;

(c) explain the use of the relevant range in such a graph.

(20 marks)

CIMA Cost Accounting 2

9.25 Preparation of a contribution graph

Z plc operates a single retail outlet selling direct to the public. Profit statements for August and September are as follows:

	August	September
Sales	80 000	90 000
Cost of sales	50 000	55 000
Gross profit	30 000	35 000
Less:		
Selling and distribution	8 000	9 000
Administration	15 000	15 000
Net profit	7 000	11 000

Required:

(a) Use the high- and low-points technique (see Chapter 10) to identify the behaviour of:
(i) cost of sales;
(ii) selling and distribution costs;
(iii) administration costs.

(4 marks)

(b) Draw a contribution break-even chart and identify the monthly break-even sales value and area of contribution.

(10 marks)

(c) Assuming a margin of safety equal to 30% of the break-even value, calculate Z plc's annual profit.

(2 marks)

(d) Z plc is now considering opening another retail outlet selling the same products. Z plc plans to use the same profit margins in both outlets and has estimated that the specific fixed costs of the second outlet will be £100 000 per annum.

Z plc also expects that 10% of its annual sales from its existing outlet would transfer to this second outlet if it were to be opened.

Calculate the annual value of sales required from the new outlet in order to achieve the same annual profit as previously obtained from the single outlet.

(5 marks)

(c) Briefly describe the cost accounting requirements of organizations of this type.

(4 marks)
(Total 25 marks)
CIMA Cost Accounting Stage 2

9.26 Preparation of a break-even chart with step fixed costs

Toowomba manufactures various products and uses CVP analysis to establish the minimum level of production to ensure profitability.

Fixed costs of £50 000 have been allocated to a specific product but are expected to increase to £100 000 once production exceeds 30 000 units, as a new factory will need to be rented in order to produce the extra units. Variable costs per unit are stable at £5 per unit over all levels of activity. Revenue from this product will be £7.50 per unit.

Required:

(a) Formulate the equations for the total cost at:
  (i) less than or equal to 30 000 units;
  (ii) more than 30 000 units.

(2 marks)

(b) Prepare a break-even chart and clearly identify the break-even point or points.

(6 marks)

(c) Discuss the implications of the results from your graph in (b) with regard to Toowomba's production plans.

(2 marks)
ACCA Paper 1.2 – Financial Information for Management

9.27 Changes in sales mix

XYZ Ltd produces two products and the following budget applies for 20 × 2:

	Product X (£)	Product Y (£)
Selling price	6	12
Variable costs	2	4
Contribution margin	4	8
Fixed costs apportioned	£100 000	£200 000
Units sold	70 000	30 000

You are required to calculate the break-even points for each product and the company as a whole and comment on your findings.

9.28 Non-graphical CVP analysis

The summarized profit and loss statement for Exewye plc for the last year is as follows:

	(£000)	(£000)
Sales (50 000 units)		1000
Direct materials	350	
Direct wages	200	
Fixed production overhead	200	
Variable production overhead	50	
Administration overhead	180	
Selling and distribution overhead	120	
		1100
Profit/(loss)		(100)

At a recent board meeting the directors discussed the year's results, following which the chairman asked for suggestions to improve the situation.

You are required as management accountant, to evaluate the following alternative proposals and to comment briefly on each:

(a) Pay salesmen a commission of 10% of sales and thus increase sales to achieve break-even point.

(5 marks)

(b) Reduce selling price by 10%, which it is estimated would increase sales volume by 30%.

(3 marks)

(c) Increase direct wage rates from £4 to £5 per hour, as part of a productivity/pay deal. It is hoped that this would increase production and sales by 20%, but advertising costs would increase by £50 000.

(4 marks)

(d) Increase sales by additional advertising of £300 000, with an increased selling price of 20%, setting a profit margin of 10%.

(8 marks)

(Total 20 marks)

CIMA P1 Cost Accounting



Cost estimation and cost behaviour

10

Determining how cost will change with output or other measurable factors of activity is of vital importance for decision-making, planning and control. The preparation of budgets, the production of performance reports, and the provision of relevant costs for decisions all depend on reliable estimates of costs and distinguishing between fixed and variable costs, at different activity levels.

Unfortunately, costs are not easy to predict, since they behave differently under different circumstances. For example, direct labour can be classified as a variable cost where a company uses casual labour hired on a daily basis so that the employment of labour can be exactly matched to meet the production requirements. In contrast, direct labour may be classified as a step-fixed cost for activities where a fixed number of people are employed and this number is maintained even when there is a temporary reduction in the quantity of the activity used. Depreciation is often quoted as a non-variable cost (also known as a fixed cost), but it may well be variable if asset value declines in direct proportion to usage. Therefore we cannot generalize by categorizing direct labour as a variable cost and depreciation as a non-variable cost.

Many costs are fairly easy to classify as purely variable (e.g. direct materials), fixed (e.g. rental of equipment), or step-fixed (e.g. labour costs) but others fall into a mixed-cost category (also known as semi-variable costs). In Chapter 2 it was pointed out that a semi-variable cost is a cost that has both a fixed and variable component. For

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- identify and describe the different methods of estimating costs;
- calculate regression equations using the high–low, scattergraph and least-squares techniques;
- identify and explain the six steps required to estimate cost functions from past data;
- explain, calculate and interpret tests of reliability;
- explain the meaning of the term 'correlation coefficient'.

example, the cost of maintenance is a semi-variable cost consisting of planned maintenance that is undertaken whatever the activity, and a variable element that is directly related to activity. Thus, it is the semi-variable costs that we need to separate into their fixed and variable categories.

Frequently the only information that is available for a semi-variable cost is the cost of the activity and a measure of activity usage. For example, records may only be available for the total cost of the maintenance activity for a given period and the number of maintenance hours used during that period. To separate the total cost into its fixed and variable elements it is necessary to use one of the techniques described in this chapter.

A major objective of this chapter is to ascertain the **activity measure** or **cost driver** that exerts the major influence of the cost of a particular activity. A cost driver can be defined as any factor whose change causes a change in the total cost of an activity. Examples of cost drivers include direct labour hours, machine hours, units of output and number of production run set-ups. Throughout this chapter the terms 'cost-driver' and 'activity measure' will be used synonymously.

General principles applying to estimating cost functions

Before we consider the various methods that are appropriate for estimating costs, we need to look at some of the terms that will be used. A **regression equation** identifies an estimated relationship between a dependent variable (cost) and one or more independent variables (i.e. an activity measure or cost driver) *based on past observations*. When the equation includes only one independent variable, it is referred to as **simple regression** and it is possible in this situation to plot the regression equation on a graph as a regression line. When the equation includes two or more independent variables, it is referred to as **multiple regression**. If there is only one independent variable and the relationship is linear, the regression line can be described by the equation for a straight line:

$$y = a + bx$$

Assuming that we wish to express the relationship between the **dependent variable** (cost) and the **independent variable** (activity), then

y = total cost for the period at an activity level of x

a = total non-variable (fixed) cost for the period

b = average variable cost per unit of activity

x = volume of activity levels or cost driver for the period

If non-variable (fixed) costs for a particular period are £5000, the average unit variable cost is £1, and direct labour hours represent the cost driver, then

$$\text{total cost} = £5000 + [£1 \times \text{direct labour hours } (x)]$$

or

$$y = a + bx$$

so that

$$y = £5000 + £1x$$

The term **cost function** is also used to refer to a regression equation that describes the relationship between a dependent variable and one or more independent variables. Cost functions are normally estimated from past cost data and activity levels. Cost estimation begins with measuring *past* relationships between total costs and the potential drivers of those costs. The objective is to use past cost behaviour patterns as an aid to predicting future costs. Any expected changes of circumstances in the future will require past data to be adjusted in line with future expectations.

There is a danger that cost functions derived from past data may be due to a spurious correlation in the data which can end at any time without warning. High correlation is only likely to continue if the relationship between the variables is economically plausible. Cost functions should not be derived solely on the basis of past observed statistical relationships. The nature of the observed statistical relationship should make sense and be economically plausible. If these conditions do not exist one cannot be confident that the estimated relationship will be repeated when the cost function is used to predict outcomes using a different set of data.

Economic plausibility exists when knowledge of operations or logic implies that a cause-and-effect relationship may exist. For example, the number of component parts is a potential cost driver for material handling costs since the greater the number of parts the higher the material handling costs. Logic suggests that a potential cause-and-effect relationship exists.

Cost estimation methods

The following approaches to cost estimation will be examined:

1. engineering methods;
2. inspection of the accounts method;
3. graphical or scattergraph method;
4. high–low method;
5. least-squares method

These approaches differ in terms of the costs of undertaking the analysis and the accuracy of the estimated cost functions. They are not mutually exclusive and different methods may be used for different cost categories.

Engineering methods

Engineering methods of analysing cost behaviour are based on the use of engineering analyses of technological relationships between inputs and outputs – for example work sampling and time and motion studies. The approach is appropriate when there is a physical relationship between costs and the cost driver. The procedure when undertaking an engineering study is to make an analysis based on *direct* observations of the underlying physical quantities required for an activity and then to convert the final results into cost estimates. Engineers, who are familiar with the technical requirements, estimate the quantities of materials and the labour and machine hours required for various operations; prices and rates are then applied to the physical measures to obtain the cost estimates. The engineering method is useful for estimating costs of repetitive processes where input–output relationships are clearly defined. For example, this method is usually satisfactory for estimating costs that are usually associated with

direct materials, labour and machine time, because these items can be directly observed and measured. However, the engineering method is not a method that can be used for separating semi-variable costs into their fixed and variable elements.

The engineering method is not restricted to manufacturing activities. It can also be applied to well-structured administrative and selling activities such as typing, invoicing and purchasing. It is not generally appropriate, however, for estimating costs that are difficult to associate directly with individual units of output, such as many types of overhead costs, since these items cannot easily be directly observed and measured.

Inspection of the accounts

The **inspection of accounts method** requires that the departmental manager and the accountant inspect each item of expenditure within the accounts for a particular period, and then classify each item of expense as a wholly fixed, wholly variable or a semi-variable cost. A single average *unit* cost figure is selected for the items that are categorized as variable, whereas a single *total* cost for the period is used for the items that are categorized as fixed. For semi-variable items the departmental manager and the accountant agree on a cost function that appears to best describe the cost behaviour. The process is illustrated in Example 10.1.

Note that repairs and maintenance have been classified as a semi-variable cost consisting of a variable element of £0.50 per unit of output plus £5000 non-variable cost. A check on the total cost calculation indicates that the estimate of a unit variable cost of £24.50 will give a total variable cost of £245 000 at an output level of 10 000 units. The non-variable costs of £50 000 are added to this to produce an estimated total cost of £295 000. The cost function is therefore $y = 50\,000 + £24.50x$. This cost function is then used for estimating total cost centre costs at other output levels.

You will see from this example that the analysis of costs into their variable and non-variable elements is very subjective. Also, the latest cost details that are available from the accounts will normally be used, and this may not be typical of either past or future cost behaviour. Whenever possible, cost estimates should be based on a series of observations.

Graphical or scattergraph method

This method involves plotting on a graph the total costs for each activity level. The total cost is represented on the vertical (Y axis) and the activity levels are recorded on the horizontal (X axis). A straight line is fitted to the scatter of plotted points by visual approximation. Figure 10.1 illustrates the procedure using the data presented in Example 10.2.

You will see by referring to Figure 10.1 that the maintenance costs are plotted for each activity level, and a straight line is drawn through the middle of the data points as closely as possible so that the distances of observations above the line are equal to the distances of observations below the line.

The point where the straight line in Figure 10.1 cuts the vertical axis (i.e. £240) represents the non-variable costs, item *a* in the regression formula $y = a + bx$. The unit variable cost *b* in the regression formula is found by observing the differences between any two points on the straight line (see the dashed line in Figure 10.1 for observations of 160 and 240 hours) and completing the following calculations:

$$\frac{\text{difference in cost}}{\text{difference in activity}} = \frac{£720 - £560}{240 \text{ hours} - 160 \text{ hours}} = £2 \text{ per hour}$$

EXAMPLE 10.1

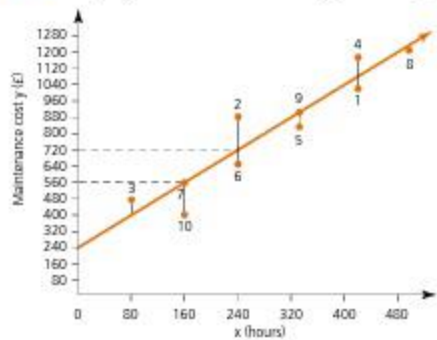
The following cost information has been obtained from the latest monthly accounts for an output level of 10 000 units for a cost centre.

	(£)
Direct materials	100 000
Direct labour	140 000
Indirect labour	30 000
Depreciation	15 000
Repairs and maintenance	10 000
	295 000

The departmental manager and the accountant examine each item of expense and analyse the expenses into their variable and non-variable elements. The analysis might be as follows:

	Unit variable cost (£)	Total non-variable cost (£)
Direct materials	10.00	
Direct labour	14.00	
Indirect labour		30 000
Depreciation		15 000
Repairs and maintenance	0.50	5 000
	24.50	50 000

FIGURE 10.1 *Graph of maintenance costs at different activity levels*



EXAMPLE 10.2

The total maintenance costs and the machine hours for the past ten four-weekly accounting periods were as follows:

Period	Machine hours x	Maintenance cost y
1	400	960
2	240	880
3	80	480
4	400	1200
5	320	800
6	240	640
7	160	560
8	480	1200
9	320	880
10	160	440

You are required to estimate the regression equation using the graphical method.

This calculation is based on a comparison of the changes in costs that can be observed on the straight line between activity levels of 160 and 240 hours. This gives a regression formula.

$$y = £240 + £2x$$

If x is assigned a value of 100 hours then

$$y = 240 + (2 \times 100) = £440$$

The graphical method is simple to use, and it provides a useful visual indication of any lack of correlation or erratic behaviour of costs. However, the method suffers from the disadvantage that the determination of exactly where the straight line should fall is subjective, and different people will draw different lines with different slopes, giving different cost estimates. To overcome this difficulty, it is preferable to determine the line of best fit mathematically using the least-squares method.

High–low method

The **high–low method** consists of selecting the periods of highest and lowest activity levels and comparing the changes in costs that result from the two levels. This approach is illustrated in Example 10.3.

The non-variable (fixed) cost can be estimated at any level of activity (assuming a constant unit variable cost) by subtracting the variable cost portion from the total cost. At an activity level of 5000 units the total cost is £22 000 and the total variable cost is £10 000 (5000 units at £2 per unit). The balance of £12 000 is therefore assumed to represent the non-variable cost. The cost function is therefore:

$$y = £12\,000 + £2x$$

EXAMPLE 10.3

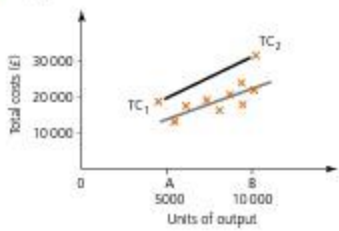
The monthly recordings for output and maintenance costs for the past 12 months have been examined and the following information has been extracted for the lowest and highest output levels:

	Volume of production (units)	Maintenance costs (£)
Lowest activity	5 000	22 000
Highest activity	10 000	32 000

The variable cost per unit is calculated as follows:

$$\frac{\text{difference in cost}}{\text{difference in activity}} = \frac{£10\,000}{5000} = £2 \text{ variable cost per unit of output}$$

FIGURE 10.2 *High–low method*



The method is illustrated in Figure 10.2, with points A and B representing the lowest and highest output levels, and TC_1 and TC_2 representing the total cost for each of these levels. The other crosses represent past cost observations for other output levels. The higher straight line joining the observations for the lowest and highest activity levels represent the costs that would be estimated for each activity level when the high–low method is used.

You will see from this illustration that the method ignores all cost observations other than the observations for the lowest and highest activity levels. Unfortunately, cost observations at the extreme ranges of activity levels are not always typical of normal operating conditions, and therefore may reflect abnormal rather than normal cost relationships. Figure 10.2 indicates how the method can give inaccurate cost estimates when they are obtained by observing only the highest and lowest output levels. It would obviously be more appropriate to incorporate all of the available observations into the cost estimate, rather than to use only two extreme observations.

The lower straight (grey) line, using the graphical or scattergraph approach described in the previous section, incorporates all of the observations. It is likely to provide a better estimate of the cost function than a method that relies on only two observations. The high–low method cannot therefore be recommended.

The least-squares method

This method determines mathematically the regression line of best fit. It is based on the principle that the sum of the squares of the vertical deviations from the line that is established using the method is less than the sum of the squares of the vertical deviations from any other line that might be drawn. The regression equation for a straight line that meets this requirement can be found from the following two equations by solving for a and b:

$$\sum y = Na + b\sum x \tag{10.1}$$

$$\sum xy = a\sum x + b\sum x^2 \tag{10.2}$$

where N is the number of observations.

Exhibit 10.1 is used to illustrate the **least-squares method**. It is assumed that past information is available only for total maintenance costs and machine hours used. We can now insert the data derived from Exhibit 10.1 into the above formulae but do note that spreadsheet packages have regression routines that will perform these calculations. Therefore it is unlikely that you will be required to manually perform these calculations. The computations are as follows:

$$19\,800 = 12a + 1260b \tag{10.1}$$

$$2\,394\,000 = 1260a + 163\,800b \tag{10.2}$$

To solve for b multiply equation (10.1) by 105 (1260/12), to give

$$2\,079\,000 = 1260a + 132\,300b \tag{10.3}$$

Subtracting equation (10.3) from equation (10.2), the 'a' terms will cancel out to yield $315\,000 = 31\,500b$, so that

$$b = £10$$

Substituting this value of b into equation (10.1) and solving for a, we have

$$19\,800 = 12a + 1260 \times 10$$

and so

$$a = 600$$

Substituting these values of a and b into the regression equation $y = a + bx$, we find that the regression line (i.e. cost function) can be described by

$$y = £600 + £10x$$

Instead of using the above formulae examination questions sometimes provide you with the following formulae to calculate the values for the terms 'a' and 'b'.

EXHIBIT 10.1

Hours x	Maintenance cost y (£)	x^2	xy
90	1 500	8 100	135 000
150	1 950	22 500	292 500
60	900	3 600	54 000
30	900	900	27 000
180	2 700	32 400	486 000
150	2 250	22 500	337 500
120	1 950	14 400	234 000
180	2 100	32 400	378 000
90	1 350	8 100	121 500
30	1 050	900	31 500
120	1 800	14 400	216 000
60	1 350	3 600	81 000
$\sum x = 1260$	$\sum y = 19\,800$	$\sum x^2 = 163\,800$	$\sum xy = 2\,394\,000$

Applying the above formulae, 10.4 and 10.5, we must first calculate the value of 'b' using formula 10.5:

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n} \tag{10.4}$$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2} \tag{10.5}$$

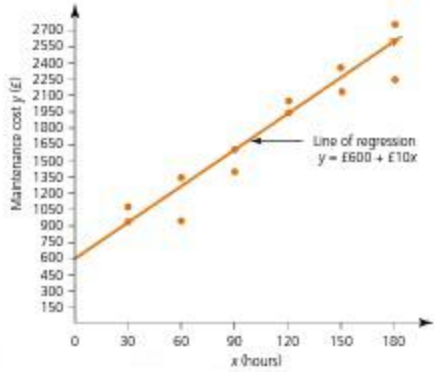
We can now use the above cost function (y = £600 + £10x) to predict the cost incurred at different activity levels, including those for which we have no past obser-

$$b = \frac{12(2\,394\,000) - (1260)(19\,800)}{12(163\,800) - (1260)^2} = 3\,780\,000/378\,000 = £10$$

$$a = \frac{19\,800}{12} - \frac{(10)(1260)}{12} = £600$$

vations. For example, at an activity level of 100 hours the cost prediction is £600 non-variable cost, plus £1000 variable cost (100 hours × £10). The regression line and the actual observations (represented by the dots) are recorded in Figure 10.3. The closer the vertical distances of the plotted actual observations are to the straight line the more reliable is the estimated cost function in predicting cost behaviour. In other words, the closer the observations are to the line the stronger the relationship between the independent variable (machine hours in our example) and the dependent variable (i.e. total maintenance cost).

FIGURE 10.3 *Regression line y = 600 + 10x compared with actual observations*



Tests of reliability



In Exhibit 10.1 the cost function was derived using machine hours as the activity measure/cost driver. However, a number of other potential cost drivers exist, such as, direct labour hours, units of output and number of production runs. Various **tests of reliability** can be applied to see how reliable potential cost drivers are in predicting the dependent variable.

One such test is the **coefficient of determination** (known as r^2). It is a **goodness of fit** measure that indicates how well the predicted values of the dependent variable (i.e. the actual cost observations represented by y), based on the chosen independent variable/cost driver (i.e. maintenance hours (x) in our example shown in Exhibit 10.1), matches the actual cost observations (Y). In particular, the coefficient of determination measures the percentage variation in the dependent variable that is explained by the independent variable.

If the regression line (y = £600 + £10x) calculated by the least-squares method for the data given in Exhibit 10.1 were to fit the actual observations perfectly, all of the observed points would lie on the regression line in Figure 10.3. You will see from this diagram that reliability is based on the size of the deviations of the actual observations (y^a) represented by the dots in Figure 10.3 from the estimated values on the regression line (y^e) represented by the straight line in Figure 10.3. The size of these deviations can be ascertained by squaring the difference between the estimated and the actual values. (The sums of the deviations will always add to zero, and it is therefore necessary to square the deviations.) The average of these squared deviations is defined as the residual variation. In statistical terms this represents the variance of the actual observations from the regression line, and is denoted by σ. The calculation of the residual variation for the information represented in Exhibit 10.1 is shown in Exhibit 10.2.

The residual variation is calculated from the formula:

$$\sigma^2 = \frac{\sum(y_a - y_e)^2}{N} = \frac{405\,000}{12} = 33\,750$$

To determine how reliable the chosen cost driver is in predicting costs, we must determine the total dispersion of the observations and compare this with the dispersion that occurs when machine hours of activity are used in predicting costs. The total dispersion of the cost observations can be found by removing machine hours from the cost equation and working out what the dispersion would then be. Any estimate of cost would then be based on a simple calculation of the average of all the actual cost observations. In Exhibit 10.2 there are 12 observations of actual cost, which add up to £19 800, the average being £1650 (£19 800/12). Let us now calculate the dispersion of the actual observations around the average. This calculation is shown in Exhibit 10.3.

The dispersion from the average σ^2, is calculated from the formula

$$\sigma^2 = \frac{\sum(y_a - \bar{y}_a)^2}{N} = \frac{3\,555\,000}{12} = 296\,250$$

The total dispersion is £296 250 but, by introducing hours into the regression equation as a possible way of predicting variations in cost, we have accounted for all but £33 750 of the total variation of £296 250. In percentage terms this means that the activity base used has failed to account for 11.39% (i.e. (33 750/296 250) × 100) of the variation of cost. In other words, 88.61% of the variation in total cost is explained by variations in the activity base (cost driver), and the remaining 11.39% is explained by either entirely random variation or random variation plus the combined effect that other (omitted variables) have on the dependent variable (total cost).

The term used for describing the calculation of 88.61% is the coefficient of determination, r^2. This is calculated from the formula

$$r^2 = 1 - \frac{\sum(y_a - y_e)^2/N}{\sum(y_a - \bar{y}_a)^2/N} = 1 - \frac{33\,750}{296\,250} = 0.8861 \qquad (10.6)$$

Instead of using the above formulae, examination questions sometimes provide you with the following formulae to calculate the value of 'r':

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}} \qquad (10.7)$$

Applying the above formula:

$$r = \frac{12(2\,394\,000) - (1260)(19\,800)}{\sqrt{[12(163\,800) - (1260)^2][12 \times 36\,225\,000) - (19\,800)^2]}}$$

$$= \frac{3\,780\,000}{4\,015\,654} = 0.941$$

so that $r^2 = (0.941)^2 = 0.8861$

EXHIBIT 10.2
Calculation of residual variation

Hours x	Actual cost (y_a)	Estimated cost (y_e) ($y = 600 + 10x$)	Deviations ($y_e - y_a$)	Deviations squared $(y_e - y_a)^2$
90	1 500	1500	0	0
150	1 950	2100	−150	22 500
60	900	1200	−300	90 000
30	900	900	0	0
180	2 700	2400	300	90 000
150	2 250	2100	150	22 500
120	1 950	1800	150	22 500
180	2 100	2400	−300	90 000
90	1 350	1500	−150	22 500
30	1 050	900	150	22 500
120	1 800	1800	0	0
60	1 350	1200	150	22 500
	19 800			405 000

EXHIBIT 10.3
Dispersion of observations around the average

Actual cost (y_a)	Average ($\bar{y}_a$)	Deviation ($y_a - \bar{y}_a$)	Deviation squared $(y_a - \bar{y}_a)^2$
1500	1650	−150	22 500
1950	1650	300	90 000
900	1650	−750	562 500
900	1650	−750	562 500
2700	1650	1050	1 102 500
2250	1650	600	360 000
1950	1650	300	90 000
2100	1650	450	202 500
1350	1650	−300	90 000
1050	1650	−600	360 000
1800	1650	150	22 500
1350	1650	−300	90 000
			3 555 000

You should note that the calculation of 36 225 000 shown in the denominator row of the above formula is derived from the sum of the squared observations from the second column of either Exhibits 10.1 or 10.2.

The degree of association between two variables such as cost and activity is normally referred to as **correlation**. The **correlation coefficient** r is the square root of the coefficient of determination. If the degree of association between the two variables is very close it will be almost possible to plot the observations on a straight line, and r and r^2 will be very near to 1. In this situation a high correlation between costs and activity exists, as illustrated in Figure 10.4 for a positive

FIGURE 10.4 *High correlation*

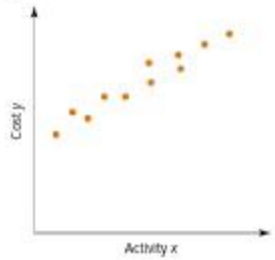
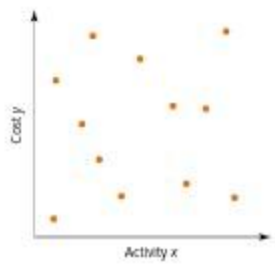


FIGURE 10.5 *No correlation*



correlation. You should note that a positive correlation exists when an increase in one variable is associated with an increase in the other variable and a negative association exists when an increase in one variable is associated with a decrease in the other variable. Alternatively, costs may be so randomly distributed that there is little or no correlation between costs and the activity base selected. The r^2 calculation will be near to zero. An illustration of the situation where no correlation exists is given in Figure 10.5.

A summary of the steps involved in estimating cost functions

We can now summarize the stages involved in the estimation of a cost function based on the analysis of past data. They are:

1. Select the dependent variable y (the cost variable) to be predicted.
2. Select the potential cost drivers.
3. Collect data on the dependent variable and cost drivers.
4. Plot the observations on a graph.
5. Estimate the cost function.
6. Test the reliability of the cost function.

It may be necessary to undertake each of these stages several times for different potential cost drivers before an acceptable cost function can be identified.

1. *Select the dependent variable y*: The choice of the cost (or costs) to be predicted will depend upon the purpose of the cost function. If the purpose is to estimate the indirect costs of a production or activity cost centre then all indirect costs associated with the production (activity) centre that are considered to have the same cause-and-effect relationship with the potential costs drivers should be grouped together. For example, if some overheads are considered to be related to performing production set-ups and others are related to machine running hours then it may be necessary to establish two cost pools: one for set-up-related costs and another for machine-related costs. A separate cost function would be established for each cost pool.
2. *Select potential cost drivers*: Examples of potential cost drivers include direct labour hours, machine hours, direct labour cost, number of units of output, number of production run set-ups, number of orders processed and weight of materials.
3. *Collect data on the dependent variable and cost drivers*: A sufficient number of past observations must be obtained to derive acceptable cost functions. The data should be adjusted to reflect any changes of circumstance, such as price changes or changes in the type of equipment used.
4. *Plot the observations on a graph*: A general indication of the relationship between the dependent variable and the cost driver can be observed from the graph. The graph will provide a visual indication as to whether a linear cost function can approximate the cost behaviour and also highlight extreme or abnormal observations. These observations should be investigated to ascertain whether they should be excluded from the analysis.
5. *Estimate the cost function*: The cost function should be estimated using the approaches described in this chapter.
6. *Test the reliability of the cost function*: The reliability of the cost function should be tested using the method described in the previous section. The cost function should be plausible. A high r^2 does not necessarily mean a cause-and-effect relationship between the two variables exists. It merely indicates that the two variables move together. The high correlation could be due to a spurious correlation in the data and end at any time without warning. High correlation is only likely to continue if the relationship between the variables is plausible. Cost functions should not be derived solely on the basis of observed past

statistical relationships. Instead, they should be used to confirm or reject beliefs that have been developed from a study of the underlying process. The nature of the statistical relationship should be understood and make economic sense.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Identify and describe the different methods of estimating costs.**

  The following approaches can be used to estimate costs: (a) engineering methods; (b) inspection of accounts method; (c) graphical or scattergraph method; (d) high–low method; (e) least squares method; and (f) multiple regression analysis. With engineering studies a detailed study of each operation is undertaken under controlled conditions, based on high levels of efficiency, to ascertain the quantities of labour and materials required. Target prices are then applied based on efficient purchasing to ascertain the standard costs. The engineering method is most appropriate for estimating direct costs for repetitive processes where input–output relationships are clearly defined. The inspection of accounts method requires that a subjective estimate is made of the fixed and variable elements for each item of expenditure within the accounts for a particular period. The remaining four methods are described below.

- **Calculate regression equations using high–low, scattergraph and least squares techniques.**

  The high-low method consists of selecting the periods of highest and lowest activity levels and comparing the changes in costs that result from these two levels. The variable cost per unit is derived by dividing the difference in cost between the two levels by the differences in activity. Fixed costs are computed by deducting the derived variable cost from total cost at either the lowest or highest output level (see Example 10.3 for an illustration of the calculations). The scattergraph method involves plotting on a graph the total cost for each observed activity level. A straight line is drawn through the middle of the scatter of points so that the distances of observations below the line are equal to the distances above the line. The variable cost per unit is derived from the straight line by dividing the difference in cost by the difference in activity. The intercept gives the estimated fixed cost (see Example 10.2 and Figure 10.1 for an illustration of the computations). The least squares method determines mathematically the line of best fit. It is based on the principle that the sum of the squares of the vertical deviations from the line that is established using this method is less than the sum of the squares of the vertical deviations from any other line that might be drawn (see Exhibit 10.1 for an illustration of the computations). Because this method uses all of the observations and determines the line of best fit mathematically it is considered superior to the high–low or scattergraph methods.

- **Identify and explain the six steps required to estimate cost functions from past data.**

  The following six steps are required: (a) select the cost (dependent) variable to be predicted; (b) select potential cost drivers (i.e. the causes of costs); (c) collect data on the dependent variable and the selected cost driver; (d) plot the observations on a graph; (e) estimate the cost function; and (f) test the reliability of the cost function.

- **Explain, calculate and interpret tests of reliability.**

  Various tests of reliability can be applied to ascertain how reliable potential independent variables (i.e. cost drivers) are in predicting the dependent variable (i.e. the actual cost observations). One such test is the coefficient of determination (r^2). It is a goodness of fit measure that indicates how well the predicted values of the dependent variable, based on the chosen independent variable, matches the actual cost observations (Y). In particular, the coefficient of determination measures the percentage variation in the dependent variable that is explained by the independent variable. You should refer to Exhibits 10.2 and 10.3 for an illustration of the calculation of the coefficient of determination.

- **Explain the meaning of the term correlation coefficient.**

  The correlation coefficient measures the degree of association between two variables. If the degree of association between the two variables is very close it will almost be possible to plot the relationship on a straight line and the correlation coefficient will be very close to 1. A positive correlation exists when an increase in one variable is associated with an increase in the other variable, whereas a negative correlation exists when an increase/decrease in one variable is associated with a decrease/increase in the other variable. Alternatively, zero correlation exists where there is little or no association between two variables.



Key terms and concepts

activity measure (p. 274)
coefficient of determination (p. 282)
correlation (p. 284)
correlation coefficient, r (p. 284)
cost driver (p. 274)
cost function (p. 275)
dependent variable (p. 274)
engineering methods (p. 275)
goodness of fit (p. 282)
high–low method (p. 278)
independent variable (p. 274)
inspection of accounts method (p. 276)
least-squares method (p. 280)
multiple regression (p. 274)
regression equation (p. 274)
simple regression (p. 274)
tests of reliability (p. 282)

Key examination points

In recent years emphasis has switched from calculation to interpretation. Do make sure you can interpret regression equations and explain the meaning of the various statistical tests of reliability. Different formulae can be used to calculate regression equations and r^2 but a formula is likely to be given (see answers to problems 10.16–10.19). The examiner will have set the question assuming you will use the formula. You will probably find that you have insufficient data or excessive calculations are required if you use an alternative formula. Do not worry if you are unfamiliar with the formula. All that is necessary is for you to enter the figures given in the question into it.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. The Beta Company is a case that is relevant to the content of this chapter.

Review questions

10.1 Explain what is meant by the term 'cost function'. (*p. 275*)

10.2 Under what circumstances can the engineering method be used to estimate costs? (*pp. 275–6*)

10.3 Describe the high-low method. (*pp. 278–9*)

10.4 What is the major limitation of the high–low method? (*p. 279*)

10.5 Describe how the scattergraph method is used to analyse costs into their fixed and variable elements. (*pp. 276–8*)

10.6 Describe the least squares method. Why is this method better than the high–low and scattergraph methods? (*pp. 279–81*)

10.7 Describe the steps that should be followed in estimating cost functions. (*pp. 386–7*)

10.8 Why is a scattergraph a useful first step in estimating cost functions? (*p. 286*)

10.9 Describe what is meant by 'goodness of fit'. (*p. 282*)

10.10 Explain the meaning of 'coefficient of determination'. (*pp. 282–5*)

Review problems

10.11 A hospital's records show that the cost of carrying out health checks in the last five accounting periods have been as follows:

Period	Number of patients seen	Total cost $
1	650	17 125
2	940	17 800
3	1260	18 650
4	990	17 980
5	1150	18 360

Using the high–low method and ignoring inflation, the estimated cost of carrying out health checks on 850 patients in period 6 is:

A $17 515 B $17 570 C $17 625 D $17 680

CIMA – Management Accounting Fundamentals

10.12 The following information for advertising and sales has been established over the past six months:

Month	Sales Revenue £000	Advertising expenditure £000
1	155	3
2	125	2.5
3	200	6
4	175	5.5
5	150	4.5
6	225	6.5

Using the high–low method, which of the following is the correct equation for linking advertising and sales from the above data?

A sales revenue = 62 500 + (25 × advertising expenditure)
B advertising expenditure = −2500 + (0.04 × sales revenue)
C sales revenue = 95 000 + (20 × advertising expenditure)
D advertising expenditure = −4750 + (0.05 × sales revenue)

ACCA – Financial Information for Management

10.13 A company incurs the following costs at various activity levels:

Total cost £	Activity level Units
250 000	5 000
312 500	7 500
400 000	10 000

Using the high–low method what is the variable cost per unit?

A £25
B £30
C £35
D £40

ACCA – Financial Information for Management

10.14 V Ltd buys IT support services from an outside agency. In its last four accounting periods, the charges made by the agency have been as follows:

Period	Usage (hours)	Charge for services $
1	3700	16 700
2	4900	20 300
3	3250	15 350
4	5800	23 000

The agency did not increase its charging rates in periods 1 to 4. It has notified V Ltd that, in period 5, it will increase the fixed element of the charge by 5% and the variable element by 10%.

If V Ltd estimates its level of usage at 5500 hours in period 5, the expected charge for IT support services will be

A $23 485
B $24 030
C $25 020
D $26 010

ACCA – Financial Information for Management

10.15 A company has established the following information for the costs and revenues at an activity level of 500 units:

	£
Direct materials	2 500
Direct labour	5 000
Production overheads	1 000
Selling costs	1 250
Total cost	9 750
Sales revenue	17 500
Profit	7 750

20% of the selling costs and 50% of the production overheads are fixed over all levels of activity.

What would be the profit at an activity level of 1000 units?

A £15 500
B £16 250
C £16 500
D £17 750

ACCA – Financial Information for Management

10.16 Regression analysis is being used to find the line of best fit ($y = a + bx$) from eleven pairs of data. The calculations have produced the following information:

$\Sigma x = 440$, $\Sigma y = 330$, $\Sigma x^2 = 17\,986$, $\Sigma y^2 = 10\,366$ and $\Sigma xy = 13\,467$

What is the value of 'a' in the equation for the line of best fit to 2 decimal places (see formulae 10.4 and 10.5 within the chapter)?

A 0.63
B 0.69
C 2.3
D 5.33

ACCA – Financial Information for Management

10.17 Brisbane Limited has recorded the following sales information for the past six months:

Month	Advertising expenditure £000	Sales revenue £000
1	1.5	30
2	2	27
3	1.75	25
4	3	40
5	2.5	32
6	2.75	38

The following has also been calculated:

Σ(Advertising expenditure) = £13 500
Σ(Sales revenue) = £192 000
Σ(Advertising expenditure × Sales revenue) = £447 250 000
Σ(Sales revenue^2) = £6 322 000 000
Σ(Advertising expenditure^2) = £32 125 000

What is the value of b, i.e. the gradient of the regression line (see formulae 10.4 and 10.5)?

A 0.070
B 0.086
C 8.714
D 14.286

ACCA – Financial Information for Management

10.18 A company uses regression analysis to establish a total cost equation for budgeting purposes.

Data for the past four months is as follows:

Month	Total cost £000	Quantity produced 000
1	57.5	1.25
2	37.5	1.00
3	45.0	1.50
4	60.0	2.00
	200.0	5.75

The gradient of the regression line is 17.14.

What is the value of a (see formulae 10.4 and 10.5)?

A 25.36
B 48.56
C 74.64
D 101.45

ACCA – Financial Information for Management

10.19 A company is seeking to establish whether there is a linear relationship between the level of advertising expenditure and the subsequent sales revenue generated.

Figures for the last eight months are as follows:

Month	Advertising Expenditure £000	Sales Revenue £000
1	2.65	30.0
2	4.25	45.0
3	1.00	17.5
4	5.25	46.0
5	4.75	44.5
6	1.95	25.0
7	3.50	43.0
8	3.00	38.5
Total	26.35	289.5

Further information is available as follows:

Σ(Advertising expenditure × Sales revenue) = £1055.875
Σ(Advertising expenditure)^2 = £101.2625
Σ(Sales revenue)^2 = £11 283.75

All of the above are given in £ million.

Required:

(a) On a suitable graph plot advertising expenditure against sales revenue or *vice versa* as appropriate. Explain your choice of axes.

(5 marks)

(b) Using regression analysis calculate using formulae 10.4 and 10.5 a line of best fit. Plot this on your graph from (a).

(5 marks)

ACCA – Financial Information for Management

10.20 Cost estimation using linear regression

Albatross Plc, the Australian subsidiary of a British packaging company, is preparing its budget for the year to 30 June 2001. In respect of fuel oil consumption, it is desired to estimate an equation of the form $y = a + bx$, where y is the total expense at an activity level x, a is the fixed expense and b is the rate of variable cost.

The following data relates to the year ending 30 June 2000:

Month	Machine hours (£000)	Fuel oil expense (£000)	Month	Machine hours (£000)	Fuel oil expense (£000)
July	34	640	January	26	500
August	30	620	February	26	500
September	34	620	March	31	530
October	39	590	April	35	550
November	42	500	May	43	580
December	32	530	June	48	680

The annual total and monthly average figures for the year ending 30 June 2000 were as follows:

	Machine hours (000)	Fuel oil expense ($)
Annual total	420	6840
Monthly average	35	570

You are required to:

(a) estimate fixed and variable elements of fuel oil expense from the above data by both the following methods:

(i) high and low points

(4 marks)

(ii) least-squares regression analysis

(8 marks)

(b) compare briefly the methods used in (a) above in relation to the task of estimating fixed and variable elements of a semi-variable cost;

(7 marks)

(c) accepting that the coefficient of determination arising from the data given in the question is approximately 0.25, interpret the significance of this fact.

(6 marks)

ICAEW Management Accounting



Measuring relevant costs and revenues for decision-making

11

In this chapter we are going to focus on measuring costs and benefits for non-routine decisions. The term **'special studies'** is sometimes used to refer to decisions that are not routinely made at frequent intervals. In other words, special studies are undertaken whenever a decision needs to be taken; such as discontinuing a product or a channel of distribution, making a component within the company or buying from an outside supplier, introducing a new product and replacing existing equipment. Special studies require only those costs and revenues that are relevant to the specific alternative courses of action to be reported. The term **'decision-relevant approach'** is used to describe the specific costs and benefits that should be reported for special studies. We shall assume that the objective when examining alternative courses of action is to maximize the present value of future net cash inflows. The calculations of present values will be explained in Chapter 15.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- distinguish between relevant and irrelevant costs and revenues;
- explain the importance of qualitative factors;
- distinguish between the relevant and irrelevant costs and revenues for the five decision-making problems described;
- describe the key concept that should be applied for presenting information for product-mix decisions when capacity constraints apply;
- explain why the book value of equipment is irrelevant when making equipment replacement decisions;
- describe the opportunity cost concept.

It is important that you note at this stage that a decision-relevant approach adopts whichever planning time horizon the decision-maker considers appropriate for a given situation. However, it is important not to focus excessively on the short term, since the objective is to maximize long-term net cash inflows. We begin by introducing the concept of relevant cost and applying this principle to special studies relating to the following:

1. special selling price decisions;
2. product-mix decisions when capacity constraints exist;
3. decisions on replacement of equipment;
4. outsourcing (make or buy) decisions;
5. discontinuation decisions.

We shall then consider in more detail the specific problems that arise in assessing the relevant costs of materials and labour.

The aim of this chapter is to provide you with an understanding of the principles that should be used to identify relevant costs and revenues. It is assumed that relevant costs can be easily measured but, in reality, some indirect relevant costs can be difficult to measure. The measurement of indirect relevant costs for decision-making using activity-based-costing techniques will be examined in the next chapter.

The meaning of relevance

The **relevant costs** and benefits required for decision-making are only those that will be affected by the decision. Costs and benefits that are independent of a decision are obviously not relevant and need not be considered when making that decision. The relevant financial inputs for decision-making purposes are therefore *future* cash flows, which will differ between the various alternatives being considered. In other words, only **differential** (or **incremental**) **cash flows** should be taken into account, and cash flows that will be the same for all alternatives are irrelevant. Since decision-making is concerned with choosing between future alternative courses of action, and nothing can be done to alter the past, then past costs (also known as sunk costs) are not relevant for decision-making. Consider a situation where an individual is uncertain as to whether he or she should purchase a monthly rail ticket to travel to work or use their car. Assuming that the individual will keep the car, whether or not he or she travels to work by train, the cost of the road fund licence and insurance will be irrelevant, since these costs remain the same irrespective of the mode of travel. The cost of petrol will, however, be relevant, since this cost will vary depending on which method of transport is chosen.

You will see that both depreciation and the allocation of common fixed costs are irrelevant for decision-making. Both are sunk costs. Depreciation represents the allocation of past costs to future periods. The original cost is unavoidable and common to all alternatives. Therefore it is irrelevant. Similarly, any allocation of common fixed costs will be irrelevant for decision-making since the choice of allocation method does not affect the level of cost to the company. It merely results in a redistribution of the same sunk cost between cost objects (e.g. products or locations within the organization).

Importance of qualitative factors

In many situations it is difficult to quantify in monetary terms all the important elements of a decision. Those factors that cannot be expressed in monetary terms are classified as **qualitative factors**. A decline in employee morale that results from redundancies arising from a closure decision is an example of a qualitative factor. It is essential that qualitative factors be brought to the attention of management during the decision-making process, since otherwise there may be a danger that a wrong decision will be made. For example, the cost of manufacturing a component internally may be more expensive than purchasing from an outside supplier. However, the decision to purchase from an outside supplier could result in the closing down of the company's facilities for manufacturing the component. The effect of such a decision might lead to redundancies and a decline in employees' morale, which could affect future output. In addition, the company will now be at the mercy of the supplier who might seek to increase prices on subsequent contracts and/or may not always deliver on time. The company may not then be in a position to meet customers' requirements. In turn, this could result in a loss of customer goodwill and a decline in future sales.

It may not be possible to quantify in monetary terms the effect of a decline in employees' morale or loss of customer goodwill, but the accountant in such circumstances should present the relevant quantifiable financial information and draw attention to those qualitative items that may have an impact on future profitability. In circumstances such as those given in the above example management must estimate the likelihood of the supplier failing to meet the company's demand for future supplies and the likely effect on customer goodwill if there is a delay in meeting orders. If the component can be obtained from many suppliers and repeat orders for the company's products are unlikely then the company may give little weighting to these qualitative factors. Alternatively, if the component can be obtained from only one supplier and the company relies heavily on repeat sales to existing customers then the qualitative factors will be of considerable importance. In the latter situation the company may consider that the quantifiable cost savings from purchasing the component from an outside supplier are insufficient to cover the risk of the qualitative factors occurring.

If it is possible qualitative factors should be expressed in quantitative non-financial terms. For example, the increase in percentage of on-time deliveries from a new production process, the reduction in customer waiting time from a decision to invest in additional cash dispensing machines and the reduction in the number of units of defective output delivered to customers arising from an investment in quality inspection are all examples of qualitative factors that can be expressed in non-financial numerical terms.

Let us now move on to apply the relevant cost approach to a variety of decision-making problems. We shall concentrate on measuring the financial outcomes but do remember that they do not always provide the full story. Qualitative factors should also be taken into account in the decision-making process.

Special pricing decisions

Special pricing decisions relate to pricing decisions outside the main market. Typically they involve one-time only orders or orders at a price below the prevailing market price. Consider the information presented in Example 11.1.

At first glance it looks as if the order should be rejected since the proposed selling price is less than the total cost of £33. A study of the cost estimates, however, indicates that during the next quarter, the direct labour, manufacturing (i.e. non-variable) fixed

EXAMPLE 11.1

The Caledonian Company is a manufacturer of clothing that sells its output directly to clothing retailers. One of its departments manufactures jumpers. The department has a production capacity of 50 000 jumpers per month. Because of the liquidation of one of its major customers the company has excess capacity. For the next quarter current monthly production and sales volume is expected to be 35 000 jumpers at a selling price of £40 per jumper. Expected costs and revenues for the next month at an activity level of 35 000 jumpers are as follows:

	(£)	(£)
Direct labour	420 000	12
Direct materials	280 000	8
Variable manufacturing overheads	70 000	2
Manufacturing non-variable overheads	280 000	8
Marketing and distribution costs	105 000	3
Total costs	1 155 000	33
Sales	1 400 000	40
Profit	245 000	7

Caledonian is expecting an upsurge in demand and considers that the excess capacity is temporary. A company in the leisure industry has offered to buy for its staff 3000 jumpers each month for the next three months at a price of £20 per jumper. The company would collect the jumpers from Caledonian's factory and thus no marketing and distribution costs will be incurred. No subsequent sales to this customer are anticipated. The company would require its company logo inserting on the jumper and Caledonian has predicted that this will cost £1 per jumper. Should Caledonian accept the offer from the company?

overheads and the marketing and distribution costs will remain the same irrespective of whether or not the order is accepted. These costs are therefore irrelevant for this decision. The direct material costs, variable manufacturing overheads and the cost of adding the leisure company's logo will be different if the order is accepted. Hence they are relevant for making the decision. The financial information required for the decision is shown in Exhibit 11.1.

You can see from Exhibit 11.1 that different approaches can be used for presenting relevant cost and revenue information. Information can be presented that includes both relevant and irrelevant costs or revenues for all alternatives under consideration. If this approach is adopted the *same* amount for the irrelevant items (i.e. those items that remain unchanged as a result of the decision which are direct labour, manufacturing non-variable overheads and the marketing and distribution costs in our example) are included for all alternatives, thus making them irrelevant to the decision. This information is presented in columns (1) and (2) in Exhibit 11.1. Alternatively, you can present cost information in columns (1) and (2) that excludes the irrelevant costs and revenues because they are identical for both alternatives. A third alternative is to present only the relevant (differential) costs. This approach is shown in column (3) of Exhibit 11.1. Note that column (3) represents the difference between columns (1) and (2). All of the methods show that the company is better off by £27 000 *per month* if the order is accepted.

EXHIBIT 11.1

Evaluation of three month order from the company in the leisure industry

	(1) Do not accept order (£ per month)	(2) Accept order (£ per month)	(3) Difference (relevant costs) (£ per month)
Direct labour	420 000	420 000	
Direct materials	280 000	304 000	24 000
Variable manufacturing overheads	70 000	76 000	6 000
Manufacturing non-variable overheads	280 000	280 000	
Inserting company logo		3 000	3 000
Marketing and distribution costs	105 000	105 000	
Total costs	1 155 000	1 188 000	33 000
Sales	1 400 000	1 460 000	60 000
Profit per month	245 000	272 000	27 000

Four important factors must be considered before recommending acceptance of the order. Most of these relate to the assumption that there are no long-run implications from accepting the offer at a selling price of £20 per jumper. First, it is assumed that the future selling price will not be affected by selling some of the output at a price below the going market price. If this assumption is incorrect then competitors may engage in similar practices of reducing their selling prices in an attempt to unload spare capacity. This may lead to a fall in the market price, which in turn would lead to a fall in profits from future sales. The loss of future profits may be greater than the short-term gain obtained from accepting special orders at prices below the existing market price. Given that Caledonian has found a customer in a different market from its normal market it is unlikely that the market price would be affected. However, if the customer had been within Caledonian's normal retail market there would be a real danger that the market price would be affected. Secondly, the decision to accept the order prevents the company from accepting other orders that may be obtained during the period at the going price. In other words, it is assumed that no better opportunities will present themselves during the period. Thirdly, it is assumed that the company has unused resources that have no alternative uses that will yield a contribution to profits in excess of £27 000 *per month*. Finally, it is assumed that the fixed costs are unavoidable for the period under consideration. In other words, we assume that the direct labour force and the fixed overheads cannot be reduced in the short term, or that they are to be retained for an upsurge in demand, which is expected to occur in the longer term.

It is important that great care is taken in presenting financial information for decision-making. For stock valuation, external financial regulations require that the jumpers must be valued at their manufacturing cost of £30. Using this cost would lead to the incorrect decision being taken. For decision-making purposes only future costs that will be relevant to the decision should be included. Costs that have been computed for meeting stock valuation requirements must not therefore be used for decision-making purposes.

When you are trying to establish which costs are relevant to a particular decision you may find that some costs will be relevant in one situation but irrelevant in another. In Example 11.1 we assumed that direct labour was not a relevant cost. The company wishes to retain the direct labour for an expected upsurge in demand and therefore

the direct labour cost will be same whether or not the offer is accepted. Alternatively, Caledonian may have had an agreement with its workforce that entitled them to at least three months' notice in the event of any redundancies. Therefore, even if Caledonian was not expecting an upsurge in demand direct labour would have been a fixed cost within the three month time horizon. But now let us consider what the relevant cost would be if direct labour consisted of casual labour who are hired on a daily basis. In this situation direct labour will be a relevant cost, since the labour costs will not be incurred if the order is not accepted.

The identification of relevant costs depends on the circumstances. In one situation a cost may be relevant, but in another the same cost may not be relevant. It is not therefore possible to provide a list of costs that would be relevant in particular situations. In each situation you should follow the principle that the relevant costs are future costs that differ among alternatives. The important question to ask when determining the relevant cost is: What difference will it make? The accountant must be aware of all the issues relating to a decision and ascertain full details of the changes that will result, and then proceed to select the relevant financial information to present to management.

Evaluation of a longer-term order

In Example 11.1 we focused on a short-term time horizon of three months. Capacity cannot easily be altered in the short term and therefore direct labour and fixed costs are likely to be irrelevant costs with respect to short-term decisions. In the longer-term, however, it may be possible to reduce capacity and spending on fixed costs and direct labour. Let us now assume that for Example 11.1 that Caledonian's assumption about an expected upsurge in the market proved to be incorrect and that it estimates that demand in the foreseeable future will remain at 35 000 jumpers *per month*. Given that it has a productive capacity of 50 000 jumpers it has sought to develop a long-term market for the unutilized capacity of 15 000 jumpers. As a result of its experience with the one-time special order with the company in the leisure industry, Caledonian has sought to develop a market with other companies operating in the leisure industry. Assume that this process has resulted in potential customers that are prepared to enter into a contractual agreement for a three year period for a supply of 15 000 jumpers *per month* at an agreed price of £25 per jumper. The cost of inserting the insignia required by each customer would remain unchanged at £1 per jumper. No marketing and distribution costs would be incurred with any of the orders. Caledonian considers that it has investigated all other possibilities to develop a market for the excess capacity. Should it enter into contractual agreements with the suppliers at £25 per jumper?

If Caledonian does not enter into contractual agreement with the suppliers the direct labour required will be made redundant. No redundancy costs will be involved. Further investigations indicate that manufacturing non-variable costs of £70 000 *per month* could be saved if a decision was made to reduce capacity by 15 000 jumpers per month. For example, the rental contracts for some of the machinery will not be renewed. Also some savings will be made in supervisory labour and support costs. Savings in marketing and distribution costs would be £20 000 *per month*. Assume also that if the capacity was reduced factory rearrangements would result in part of the facilities being rented out at £25 000 *per month*. Note that because variable costs vary directly with changes in volume, direct materials and variable manufacturing overheads will decline by 30% if capacity is reduced by 30% from 50 000 to 35 000 jumpers.

We are now faced with a longer-term decision where some of the costs that were fixed in the short term can be changed in the longer term. The appropriate financial data for the analysis is shown in Exhibit 11.2. Note that in Exhibit 11.2 the information for an

EXHIBIT 11.2

Evaluation of orders for the unutilized capacity over a three year time horizon

Monthly sales and production in units	(1) Do not accept orders 35 000 (£)	(2) Accept the orders 50 000 (£)	(3) Difference (relevant costs) 15 000 (£)
Direct labour	294 000	420 000	126 000
Direct materials	280 000	400 000	120 000
Variable manufacturing overheads	70 000	100 000	30 000
Manufacturing non-variable overheads	210 000	280 000	70 000
Inserting company logo		15 000	15 000
Marketing and distribution costs	85 000	105 000	20 000
Total costs	939 000	1 320 000	381 000
Revenues from rental of facilities	25 000		25 000
Sales revenues	1 400 000	1 775 000	(375 000)
Profit per month	486 000	455 000	31 000

activity of 35 000 jumpers incorporates the changes arising from the capacity reduction whereas the information presented for the same activity level in Exhibit 11.1 is based on the assumption that capacity will be maintained at 50 000 jumpers. Therefore the direct labour cost in Exhibit 11.1 is £420 000 because it represents the labour required to meet demand at full capacity. If capacity is permanently reduced from 50 000 to 35 000 jumpers (i.e. a 30% reduction) it is assumed that direct labour costs will be reduced by 30% from £420 000 to £294 000. This is the amount shown in Exhibit 11.2.

A comparison of the monthly outcomes reported in columns (1) and (2) of Exhibit 11.2 indicates that the company is better off by £31 000 *per month* if it reduces capacity to 35 000 jumpers, assuming that there are no qualitative factors. Instead of presenting the data in columns (1) and (2) you can present only the differential (relevant) costs and revenues shown in column (3). This approach also indicates that the company is better off by £31 000 per month. Note that the entry in column (3) of £25 000 is the lost revenues from the rent of the unutilized capacity if the company accepts the orders. This represents the opportunity cost of accepting the orders.

Where the choice of one course of action requires that an alternative course of action is given up, the financial benefits that are forgone or sacrificed are known as **opportunity costs**. In other words, opportunity costs represent the lost contribution to profits arising from the best use of the alternative forgone. Opportunity costs only arise when resources are scarce and have alternative uses. Thus, in our illustration the capacity allocated to producing 15 000 jumpers results in an opportunity cost (i.e. the lost revenues from the rent of the capacity) of £25 000 per month.

In Exhibit 11.2 all of the costs and revenues are relevant to the decision because some of the costs that were fixed in the short term could be changed in the longer term. Therefore whether or not a cost is relevant often depends on the time horizon under consideration. Thus it is important that the information presented for decision-making relates to the appropriate time horizon. If inappropriate time horizons are selected there is a danger that misleading information will be presented. Remember that our aim should always be to maximize *long-term* net cash inflows.



Assumed irrelevance of fixed overheads

A survey of approximately 250 UK manufacturing companies by Brealey (2006) indicated that approximately 70% used costs incorporating the assignment of a share of fixed overheads for decision-making (e.g. make or buy and cost reduction decisions) and the remaining 30% relied on using direct costs (excluding a share of the fixed overheads). Fifty-four of the respondents were interviewed and the major reasons for relying only on direct costs related to the fact that they represented the majority of the costs. Therefore indirect costs were not considered relevant for decision-making. These respondents appeared to adopt a short-term focus in determining the relevant costs for decision-making. The following represent the responses from two interviewees relating to make or buy decisions:

> *It's really what you're going to save. If you send something out you're not going to save fixed overhead at all, you'd be foolish to put fixed overhead into something. So if you're comparing it with another plant you need to look at the variable cost.*

> *Any fixed overhead is irrelevant to that decision. It will remain regardless of whether we make or buy a product in. Therefore we look at the direct costs, the labour and material costs when we're doing that comparison. It's simply it would be incorrect to include costs that are not going to change.*

Source: Brealey, J. A. (2006), The calculation of product costs and their use in decision-making in the British Manufacturing Industry, PhD dissertation, University of Huddersfield

Product-mix decisions when capacity constraints exist

In the short term sales demand may be in excess of current productivity capacity. For example, output may be restricted by a shortage of skilled labour, materials, equipment or space. When sales demand is in excess of a company's productive capacity, the resources responsible for limiting the output should be identified. These scarce resources are known as **limiting factors**. Within a short-term time period it is unlikely that production constraints can be removed and additional resources acquired. Where limiting factors apply, profit is maximized when the greatest possible contribution to profit is obtained each time the scarce or limiting factor is used. Consider Example 11.2.

In this situation the company's ability to increase its output and profits/net cash inflows is limited in the short term by the availability of machine capacity. You may think, when first looking at the available information, that the company should give top priority to producing component X, since this yields the highest contribution per unit sold, but this assumption would be incorrect. To produce each unit of component X, 6 scarce machine hours are required, whereas components Y and Z use only 2 hours and 1 hour respectively of scarce machine hours. By concentrating on producing components Y and Z, the company can sell 2000 units of each component and still have some machine capacity left to make component X. If the company concentrates on producing component X it will only be able to meet the maximum sales demand of component X, and will have no machine capacity left to make components Y or Z. The way in which you should determine the optimum production plan is to calculate the contribution per limiting factor for each component and then to rank the components in order of profitability based on this calculation.

EXAMPLE 11.2

Rhine Autos is a major European producer of automobiles. A department within one of its divisions supplies component parts to firms operating within the automobile industry. The following information is provided relating to the anticipated demand and the productive capacity for the next quarter in respect of three components that are manufactured within the department:

	Component X	Component Y	Component Z
Contribution per unit of output	£12	£10	£6
Machine hours required per unit of output	6 hours	2 hours	1 hour
Estimated sales demand	2 000 units	2000 units	2000 units
Required machine hours for the quarter	12 000 hours	4000 hours	2000 hours

Because of the breakdown of one of its special purpose machines capacity is limited to 12 000 machine hours for the period, and this is insufficient to meet total sales demand. You have been asked to advise on the mix of products that should be produced during the period.

Using the figures in the present example the result would be as follows:

	Component X	Component Y	Component Z
Contribution per unit	£12	£10	£6
Machine hours required	6 hours	2 hours	1 hour
Contribution per machine hour	£2	£5	£6
Ranking	3	2	1

The company can now allocate the 12 000 scarce machine hours in accordance with the above rankings. The first choice should be to produce as much as possible of component Z. The maximum sales are 2000 units, and production of this quantity will result in the use of 2000 machine hours, thus leaving 10 000 unused hours. The second choice should be to produce as much of component Y as possible. The maximum sales of 2000 units will result in the use of 4000 machine hours. Production of both components Z and Y require 6000 machine hours, leaving a balance of 6000 hours for the production of component X, which will enable 1000 units of component X to be produced.

We can now summarize the allocation of the scarce machine hours:

Production	Machine hours used	Balance of machine hours available
2000 units of Z	2000	10 000
2000 units of Y	4000	6 000
1000 units of X	6000	—

This production programme results in the following total contribution:

	(£)
2000 units of Z at £6 per unit contribution	12 000
2000 units of Y at £10 per unit contribution	20 000
1000 units of X at £12 per unit contribution	12 000
Total contribution	44 000

Always remember that it is necessary to consider other qualitative factors before the production programme is determined. For example, customer goodwill may be lost causing a fall in future sales if the company is unable to supply all three products to, say, 150 of its regular customers. Difficulties may arise in applying this procedure when there is more than one scarce resource. It could not be applied if, for example, labour hours were also scarce and the contribution per labour hour resulted in component Y being ranked first, followed by components X and Z. In this type of situation, where more than one resource is scarce, it is necessary to resort to linear programming methods in order to determine the optimal production programme. The application of linear programming to decision-making when there are several scarce resources will be examined in Chapter 12.

The approach described above can also be applied in non-manufacturing organizations (see Real World Views 11.2). For example, in a major UK retail store display space is the limiting factor. The store maximizes its short-term profits by allocating shelving space on the basis of contribution per metre of shelving space.

Finally, it is important that you remember that the approach outlined in this section applies only to those situations where capacity constraints cannot be removed in the short term. In the longer term additional resources should be acquired if the contribution from the extra capacity exceeds the cost of acquisition.

Replacement of equipment – the irrelevance of past costs

Replacement of equipment is a capital investment or long-term decision that requires the use of discounted cash flow procedures. These procedures are discussed in detail in Chapter 15, but one aspect of asset replacement decisions which we will consider at this stage is how to deal with the book value (i.e. the **written-down value**) of old equipment. This is a problem that has been known to cause difficulty, but the correct approach is to apply relevant cost principles (i.e. past or sunk costs are irrelevant for decision-making). We shall now use Example 11.3 to illustrate the irrelevance of the book value of old equipment in a replacement decision. To avoid any possible confusion, it will be assumed here that £1 of cash inflow or outflow in year 1 is equivalent to £1 of cash inflow or outflow in, say, year 3. Such an assumption would in reality be incorrect and you will see why this is so in Chapter 15, but by adopting this assumption at this stage, the replacement problem can be simplified and we can focus our attention on the treatment of the book value of the old equipment in the replacement decision.

You can see from an examination of Example 11.3 that the total costs over a period of three years for each of the alternatives are as follows:

EXAMPLE 11.3

A division within Rhine Autos purchased a machine three years ago for £180 000. Depreciation using the straight line basis, assuming a life of six years and with no salvage value, has been recorded each year in the financial accounts. The present written-down value of the equipment is £90 000 and it has a remaining life of three years. Management is considering replacing this machine with a new machine that will reduce the variable operating costs. The new machine will cost £70 000 and will have an expected life of three years with no scrap value. The variable operating costs are £3 per unit of output for the old machine and £2 per unit for the new machine. It is expected that both machines will be operated at a capacity of 20 000 units per annum. The sales revenues from the output of both machines will therefore be identical. The current disposal or sale value of the old machine is £40 000 and it will be zero in three years time.

	(1) Retain present machine (£)	(2) Buy replacement machine (£)	(3) Difference (relevant costs/ revenues) (£)
Variable/incremental operating costs:			
20 000 units at £3 per unit for 3 years	180 000		
20 000 units at £2 per unit for 3 years		120 000	(60 000)
Old machine book value:			
3-year annual depreciation charge	90 000		
Lump sum write-off		90 000	
Old machine disposal value		(40 000)	(40 000)
Initial purchase price of new machine		70 000	70 000
Total cost	270 000	240 000	30 000

You can see from the above analysis that the £90 000 book value of the old machine is irrelevant to the decision. Book values are not relevant costs because they are past or sunk costs and are therefore the same for all potential courses of action. If the present machine is retained, three years' depreciation at £30 000 per annum will be written off annually whereas if the new machine is purchased the £90 000 will be written off as a lump sum if it is replaced. Note that depreciation charges for the new machine are not included in the analysis since the cost of purchasing the machine is already included in the analysis. The sum of the annual depreciation charges are equivalent to the purchase cost. Thus, including both items would amount to double counting.

The above analysis shows that the costs of operating the replacement machine are £30 000 less than the costs of operating the existing machine over the three year period. Again there are several different methods of presenting the information. They all show a £30 000 advantage in favour of replacing the machine. You can present the information shown in columns (1) and (2) above, as long as you ensure that the same amount for the irrelevant items is included for all alternatives. Instead, you can present columns (1) and (2) with the irrelevant item (i.e. the £90 000) omitted or you can present the differential items listed in column (3). However, if you

adopt the latter approach you will probably find it more meaningful to restate column (3) as follows:

	(£)
Savings on variable operating costs (3 years)	60 000
Sale proceeds of existing machine	40 000
	100 000
Less purchase cost of replacement machine	70 000
Savings on purchasing replacement machine	30 000

Outsourcing and make or buy decisions

Outsourcing is the process of obtaining goods or services from outside suppliers instead of producing the same goods or providing the same services within the organization. Decisions on whether to produce components or provide services within the organization or to acquire them from outside suppliers are called outsourcing or make or buy decisions. Many organizations outsource some of their activities such as their payroll and purchasing functions or the purchase of speciality components. Increasingly municipal local services such as waste disposal, highways and property maintenance are being outsourced. Consider the information presented in Example 11.4 (Case A).

At first glance it appears that the component should be outsourced since the purchase price of £30 is less than the current total unit cost of manufacturing. However, the unit costs include some costs that will be unchanged whether or not the components are outsourced. These costs are therefore not relevant to the decision. Assume also that there are no alternative uses of the released capacity if the components are outsourced. The appropriate cost information is presented in Exhibit 11.3 (Section A). Alternative approaches to presenting relevant cost and revenue information are presented. In columns (1) and (2) of Exhibit 11.3 cost information is presented that includes both relevant and irrelevant costs for both alternatives under consideration. The same amount for non-manufacturing overheads, which are irrelevant, is included for both alternatives. By including the same amount in both columns the cost is made irrelevant. Alternatively, you can present cost information in columns (1) and (2) that excludes any irrelevant costs and revenues because they are identical for both alternatives. Adopting either approach will result in a difference of £60 000 in favour of making component A.

The third approach is to list only the relevant costs, cost savings and any relevant revenues. This approach is shown in column (3) of Exhibit 11.3 (Section A). This column represents the differential costs or revenues and it is derived from the differences between columns (1) and (2). In column (3) only the information that is relevant to the decision is presented. You will see that this approach compares the relevant costs of making directly against outsourcing. It indicates that the additional costs of making component A are £240 000 but this enables purchasing costs of £300 000 to be saved. Therefore the company makes a net saving of £60 000 from making the components compared with outsourcing.

However, you will probably find column (3) easier to interpret if it is restated as two separate alternatives as shown in Exhibit 11.3. All of the approaches described in this and the preceding paragraph yield identical results. You can adopt any of them. It is a matter of personal preference.

EXAMPLE 11.4

Case A

One of the divisions within Rhine Autos is currently negotiating with another supplier regarding outsourcing component A that it manufactures. The division currently manufactures 10 000 units per annum of the component. The costs currently assigned to the components are as follows:

	Total costs of producing 10 000 components (£)	Unit cost (£)
Direct materials	120 000	12
Direct labour	100 000	10
Variable manufacturing overhead costs (power and utilities)	10 000	1
Fixed manufacturing overhead costs	80 000	8
Share of non-manufacturing overheads	50 000	5
Total costs	360 000	36

The above costs are expected to remain unchanged in the foreseeable future if the Rhine Autos division continues to manufacture the components. The supplier has offered to supply 10 000 components per annum at price of £30 per unit guaranteed for a minimum of three years. If Rhine Autos outsources component A the direct labour force currently employed in producing the components will be made redundant. No redundancy costs will be incurred. Direct materials and variable overheads are avoidable if component A is outsourced. Fixed manufacturing overhead costs would be reduced by £10 000 per annum but non-manufacturing costs would remain unchanged. Assume initially that the capacity that is required for component A has no alternative use. Should the Division of Rhine Autos make or buy the component?

Case B

Assume now that the extra capacity that will be made available from outsourcing component A can be used to manufacture and sell 10 000 units of part B at a price of £34 per unit. All of the labour force required to manufacture component A would be used to make part B. The variable manufacturing overheads, the fixed manufacturing overheads and non-manufacturing overheads would be the same as the costs incurred for manufacturing component A. The materials required to manufacture component A would not be required but additional materials required for making part B would cost £13 per unit. Should Rhine Autos outsource component A?

EXHIBIT 11.3

Evaluating a make or buy decision

Section A – Assuming there is no alternative use of the released capacity

	Total cost of continuing to make 10 000 components (1) (£ per annum)	Total cost of buying 10 000 components (2) (£ per annum)	Difference (relevant) (cost) (3) (£ per annum)
Direct materials	120 000		120 000
Direct labour	100 000		100 000
Variable manufacturing overhead costs (power and utilities)	10 000		10 000
Fixed manufacturing overhead costs	80 000	70 000	10 000
Non-manufacturing overheads	50 000	50 000	
Outside purchase cost incurred/(saved)		300 000	(300 000)
Total costs incurred/(saved) per annum	360 000	420 000	(60 000)

Column 3 is easier to interpret if it is restated as two separate alternatives as follows:

	Relevant cost of making component A (£ per annum)	Relevant cost of outsourcing component A (£ per annum)
Direct materials	120 000	
Direct labour	100 000	
Variable manufacturing overhead costs	10 000	
Fixed manufacturing overhead costs	10 000	
Outside purchase cost incurred		300 000
	240 000	300 000

Section B – Assuming the released capacity has alternative uses

	(1) Make component A and do not make part B (£ per annum)	(2) Buy component A and do not make part B (£ per annum)	(3) Buy component A and make part B (£ per annum)
Direct materials	120 000		130 000
Direct labour	100 000		100 000
Variable manufacturing overhead costs	10 000		10 000
Fixed manufacturing overhead costs	80 000	70 000	80 000
Non-manufacturing overheads	50 000	50 000	50 000
Outside purchase cost incurred		300 000	300 000
Revenues from sales of part B			(340 000)
Total net costs	360 000	420 000	330 000



Measures of product attractiveness in retail operations

Shelf space limits the quantity and variety of products offered by a retail operation. The visibility of a particular stock-keeping unit (SKU) and probability of a stock-out are related to the space allocated to the SKU. Total contribution for the retail operation is influenced by how shelf space is allocated to the SKUs. For retailers, shelf space 'is their life blood – and it's very limited and expensive'. Shelf space, accordingly, can be treated as a constraint in retailing operations. The most attractive SKU is the SKU that generates the greatest contribution per unit of space (square foot or cubic foot). To calculate contribution, all incremental expenses are deducted from incremental revenue. Incremental revenues include retail price and other direct revenue such as deals, allowances, forward-buy and prompt-payment discounts. Incremental expenses include any money paid out as a result of selling one unit of a particular item. Included in the incremental expenses would be the invoice unit cost and other invoiced amounts (shipping charges, for example) that can be traced directly to the sale of the particular item. Incremental revenues and expenses are found by dividing case values by the number of units per case.

If capacity is not changed, then the relevant costs are the incremental costs rather than full costs. The choice of low direct product cost items (i.e. a full product cost including a share of the fixed warehouse, transport and storage costs) over high direct product cost items is essentially a choice to use less of the capacity that has already been paid for. If the costs of capacity are fixed, then using less capacity will not save money. Like the product mix problem, the answer to the space management problem is how to allocate existing capacity so that profit is maximized. To maximize profits where profits are constrained by space limitations, capacity should be allocated on the basis of the SKU that generates the greatest contribution per unit of space.



Source: © J Sainsbury plc 2003

Source: Adapted from Gardiner, S.C., Measures of product attractiveness and the theory of constraints, *International Journal of Retail and Distribution*, 1993, Vol. 21, No. 7, pp. 37–40. http://www.emeraldinsight.com/ijrdm.htm

Let us now re-examine the situation when the extra capacity created from not producing component A has an alternative use. Consider the information presented in Example 11.4 (Case B). The management of Rhine Autos now have three alternatives. They are:

1. Make component A and do not make part B.
2. Outsource component A and do not make part B.
3. Outsource component A and make and sell part B.

It is assumed there is insufficient capacity to make both component A and part B. The appropriate financial information is presented in Exhibit 11.3 (Section B). You will see that, with the exception of non-manufacturing costs, all of the items differ

between the alternatives and are therefore relevant to the decision. Again we can omit the non-manufacturing costs from the analysis or include the same amount for all alternatives. Either approach makes them irrelevant. The first two alternatives that do not involve making and selling part B are identical to the alternatives considered in Case A so the information presented in columns (1) and (2) in sections A and B of Exhibit 11.3 are identical. In column 3 of section B the costs incurred in making part B in respect of direct labour, variable and fixed manufacturing overheads and non-manufacturing overheads are identical to the costs incurred in making component A. Therefore the same costs for these items are entered in column 3. However, different materials are required to make part B and the cost of these (10 000 units at £13) are entered in column 3. In addition, the revenues from the sales of part B are entered in column 3. Comparing the three columns in Section B of Exhibit 11.3 indicates that buying component A and using the extra capacity that is created to make part B is the preferred alternative.

The incremental costs of outsourcing are £60 000 more than making component B (see Section A of Exhibit 11.3) but the extra capacity released from outsourcing component A enables Rhine Autos to obtain a profit contribution of £90 000 (£340 000 incremental sales from part B less £250 000 incremental/relevant costs of making part B). The overall outcome is a £30 000 net benefit from outsourcing. Note that the relevant costs of making part B are the same as those of making component A, apart from direct materials, which cost £130 000. In other words, the relevant (incremental) costs of making part B (compared with outsourcing) are as follows:

	(£)
Direct materials	130 000
Direct labour	100 000
Variable manufacturing overhead costs	10 000
Fixed manufacturing overhead costs	10 000
	250 000

Discontinuation decisions

Most organizations periodically analyse profits by one or more cost objects, such as products or services, customers and locations. Periodic profitability analysis provides attention-directing information that highlights those unprofitable activities that require a more detailed appraisal (sometimes referred to as a special study) to ascertain whether or not they should be discontinued. In this section we shall illustrate how the principle of relevant costs can be applied to discontinuation decisions. Consider Example 11.5. You will see that it focuses on a decision whether to discontinue operating a sales territory, but the same principles can also be applied to discontinuing products, services or customers.

In Example 11.5 Aero Company analyses profits by locations. Profits are analysed by regions which are then further analysed by sales territories within each region. It is apparent from Example 11.5 that the South East Asian region is profitable but the profitability analysis suggests that the Bangkok sales territory is unprofitable. A more detailed study is required to ascertain whether it should be discontinued. Let us assume that this study indicates that:

1 Discontinuing the Bangkok sales territory will eliminate cost of goods sold, salespersons salaries, sales office rent and regional and headquarters expenses arising from cause-and-effect cost allocations.

EXAMPLE 11.5

The Aero Company is a wholesaler who sells its products to retailers throughout the Far East. Aero's headquarters is in Hong Kong. The company has adopted a regional structure with each region consisting of 3–5 sales territories. Each region has its own regional office and a warehouse which distributes the goods directly to the customers. Each sales territory also has an office where the marketing staff are located. The South East Asian region consists of three sales territories with offices located in Singapore, Kuala Lumpur and Bangkok. The budgeted results for the next quarter are as follows:

	Singapore (£000s)	Kuala Lumpur (£000s)	Bangkok (£000s)	Total (£000s)
Cost of goods sold	800	850	1000	2650
Salespersons salaries	160	200	240	600
Sales office rent	60	90	120	270
Depreciation of sales office equipment	20	30	40	90
Apportionment of warehouse rent	24	24	24	72
Depreciation of warehouse equipment	20	16	22	58
Regional and headquarters costs				
Cause-and-effect allocations	120	152	186	458
Arbitrary apportionments	360	400	340	1100
Total costs assigned to each location	1564	1762	1972	5298
Reported profit/(loss)	236	238	(272)	202
Sales	1800	2000	1700	5500

Assuming that the above results are likely to be typical of future quarterly performance should the Bangkok territory be discontinued?

2 Discontinuing the Bangkok sales territory will have no effect on depreciation of sales office equipment, warehouse rent, depreciation of warehouse equipment and regional and headquarters expenses arising from arbitrary cost allocations. The same costs will be incurred by the company for all of these items even if the sales territory is discontinued.

Note that in the event of discontinuation the sales office will not be required and the rental will be eliminated whereas the warehouse rent relates to the warehouse for the region as a whole and, unless the company moves to a smaller warehouse, the rental will remain unchanged. It is therefore not a relevant cost. Discontinuation will result in the creation of additional space and if the extra space remains unused there are no financial consequences to take into account. However, if the additional space can be sub-let to generate rental income the income would be incorporated as an opportunity cost for the alternative of keeping the Bangkok territory.

Exhibit 11.4 shows the relevant cost computations. Column (1) shows the costs incurred by the company if the sales territory is kept open and column (2) shows the costs that would be incurred if a decision was taken to drop the sales territory. Therefore in column (2) only those costs that would be eliminated (i.e. those items

EXHIBIT 11.4

Relevant cost analysis relating to the discontinuation of the Bangkok territory

	Total costs and revenues to be assigned		
	(1) Keep Bangkok territory open (£000s)	(2) Discontinue Bangkok territory (£000s)	(3) Difference incremental costs and revenues (£000s)
Cost of goods sold	2650	1650	1000
Salespersons salaries	600	360	240
Sales office rent	270	150	120
Depreciation of sales office equipment	90	90	
Apportionment of warehouse rent	72	72	
Depreciation of warehouse equipment	58	58	
Regional and headquarters costs			
Cause-and-effect allocations	458	272	186
Arbitrary apportionments	1100	1100	
Total costs to be assigned	5298	3752	1546
Reported profit	202	48	154
Sales	5500	3800	1700

listed in item (1) above) are deducted from column (1). You can see that the company will continue to incur some of the costs (i.e. those items listed in item (2) above) even if the Bangkok territory is closed and these costs are therefore irrelevant to the decision. Again you can either include, or exclude, the irrelevant costs in columns (1) and (2) as long as you ensure that the same amount of irrelevant costs is included for both alternatives if you adopt the first approach. Both approaches will show that future profits will decline by £154 000 if the Bangkok territory is closed. Alternatively, you can present just the relevant costs and revenues shown in column (3). This approach indicates that keeping the sales territory open results in additional sales revenues of £1 700 000 but additional costs of £1 546 000 are incurred giving a contribution of £154 000 towards fixed costs and profits.

You will have noted that we have assumed that the regional and headquarters costs assigned to the sales territories on the basis of cause-and-effect allocations can be eliminated if the Bangkok territory is discontinued. These are indirect costs that fluctuate in the longer-term according to the demand for them and it is assumed that the selected allocation base, or cost driver, provides a reasonably accurate measure of resources consumed by the sales territories. Cause-and-effect allocation bases assume that if the cause is eliminated or reduced, the effect (i.e. the costs) will be eliminated or reduced. If cost drivers are selected that result in allocations that are inaccurate measures of resources consumed by cost objects (i.e. sales territories) the relevant costs derived from these allocations will be incorrect and incorrect decisions may be made. We shall explore this issue in some detail in Chapter 13 when we look at activity-based costing.

Determining the relevant costs of direct materials

So far in this chapter we have assumed, when considering various decisions, that any materials required would not be taken from existing stocks but would be purchased at a later date, and so the estimated purchase price would be the relevant material cost. Where materials are taken from existing stock do remember that the original purchase price represents a past or sunk cost and is therefore irrelevant for decision-making. If the materials are to be replaced then using the materials for a particular activity will necessitate their replacement. Thus, the decision to use the materials on an activity will result in additional acquisition costs compared with the situation if the materials were not used on that particular activity. Therefore the future **replacement cost** represents the relevant cost of the materials.

Consider now the situation where the materials have no further use apart from being used on a particular activity. If the materials have some realizable value, the use of the materials will result in lost sales revenues, and this lost sales revenue will represent an opportunity cost that must be assigned to the activity. Alternatively, if the materials have no realizable value the relevant cost of the materials will be zero.

Determining the relevant costs of direct labour

Determining the direct labour costs that are relevant to short-term decisions depends on the circumstances. Where a company has temporary spare capacity and the labour force is to be maintained in the short term, the direct labour cost incurred will remain the same for all alternative decisions. The direct labour cost will therefore be irrelevant for short-term decision-making purposes. Consider now a situation where casual labour is used and where workers can be hired on a daily basis; a company may then adjust the employment of labour to exactly the amount required to meet the production requirements. The labour cost will increase if the company accepts additional work, and will decrease if production is reduced. In this situation the labour cost will be a relevant cost for decision-making purposes.

In a situation where full capacity exists and additional labour supplies are unavailable in the short term, and where no further overtime working is possible, the only way that labour resources could then be obtained for a specific order would be to reduce existing production. This would release labour for the order, but the reduced production would result in a lost contribution, and this lost contribution must be taken into account when ascertaining the relevant cost for the specific order. The relevant labour cost per hour where full capacity exists is therefore the hourly labour rate plus an opportunity cost consisting of the contribution per hour that is lost by accepting the order.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Distinguish between relevant and irrelevant costs and revenues.**

  Relevant costs/revenues represent those future costs/revenues that will be changed by a particular decision, whereas irrelevant costs/revenues will not be affected by that

decision. In the short-term total profits will be increased (or total losses decreased) if a course of action is chosen where relevant revenues are in excess of relevant costs.

- **Explain the importance of qualitative factors.**

  Quantitative factors refer to outcomes that can be measured in numerical terms. In many situations it is difficult to quantify all the important elements of a decision. Those factors that cannot be expressed in numerical terms are called qualitative factors. Examples of qualitative factors include changes in employee morale and the impact of being at the mercy of a supplier when a decision is made to close a company's facilities and sub-contract components. Although qualitative factors cannot be quantified it is essential that they are taken into account in the decision-making process.

- **Distinguish between the relevant and irrelevant costs and revenues for the five decision-making problems described.**

  The five decision-making problems described were: (a) special selling price decisions; (b) product-mix decisions when capacity constraints apply; (c) decisions on the replacement of equipment; (d) outsourcing (make or buy) decisions; and (e) discontinuation decisions. Different approaches can be used for presenting relevant cost and revenue information. Information can be presented that includes both relevant and irrelevant items for all alternatives under consideration. If this approach is adopted the same amount for the irrelevant items (i.e. those items that remain unchanged as a result of the decision) are included for all alternatives thus making them irrelevant for the decision. Alternatively, information can be presented that lists only the relevant costs for the alternatives under consideration. Where only two alternatives are being considered a third approach is to present only the relevant (differential) items. You can adopt either approach. It is a matter of personal preference. All three approaches were illustrated for the five decision-making problems.

- **Describe the key concept that should be applied for presenting information for product-mix decisions when capacity constraints apply.**

  The information presented should rank the products by the contribution per unit of the constraining or limiting factor (i.e. the scarce resource). The capacity of the scarce resource should allocated according to this ranking.

- **Explain why the book value of equipment is irrelevant when making equipment replacement decisions.**

  The book value of equipment is a past (sunk) cost that cannot be changed for any alternative under consideration. Only future costs or revenues that will differ between alternatives are relevant for replacement decisions.

- **Describe the opportunity cost concept.**

  Where the choice of one course of action requires that an alternative course of action be given up the financial benefits that are forgone or sacrificed are known as opportunity costs. Opportunity costs thus represent the lost contribution to profits arising from the best alternative forgone. They arise only when the resources are scarce and have alternative uses. Opportunity costs must therefore be included in the analysis when presenting relevant information for decision-making.

- **Additional learning objective presented in Appendix 11.1.**

  The appendix to this chapter includes the following additional learning objective: calculate the optimal selling price using differential calculus. This topic is normally dealt with in second stage cost and management accounting courses, but recently

some professional accountancy examining bodies have included this topic in first stage courses. You should therefore check your course content to ascertain if you will need to read the appendix.

Appendix 11.1 Calculating optimum selling prices using differential calculus



The optimal output is determined at the point where marginal revenue equals marginal cost (see Chapter 2 for an explanation of the terms marginal revenue and marginal cost). The highest selling price at which the optimum output can be sold determines the optimal selling price. If demand and cost schedules are known, it is possible to derive simultaneously the optimum output level and selling price using differential calculus. Consider Example 11A.1.

EXAMPLE 11A.1

A division within the Caspian Company sells a single product. Divisional fixed costs are £700 000 per annum and a variable cost of £70 is incurred for each additional unit produced and sold over a very large range of outputs. The current selling price for the product is £160, and at this price 10 000 units are demanded per annum. It is estimated that for each successive increase in price of £2 annual demand will be reduced by 500 units. Alternatively, for each £2 reduction in price demand will increase by 500 units.

Calculate the optimum output and price for the product assuming that if prices are set within each £2 range there will be a proportionate change in demand.

The first step when calculating the optimum selling price is to calculate total cost and revenue functions. The total cost (TC) function is

$$TC = £700\,000 + £70x$$

where x is the annual level of demand and output.

At present the selling price is £160 and demand is 10 000 units. Each increase or decrease in price of £2 results in a corresponding decrease or increase in demand of 500 units. Therefore, if the selling price were increased to £200, demand would be zero. To increase demand by one unit, selling price must be reduced by £0.004 (£2/500 units). Thus the maximum selling price (SP) for an output of x units is

$$SP = £200 - £0.004x$$

Assuming that the output demanded is 10 000 units SP = £200 – £0.004 (10 000) = £160. Therefore if demand is 10 000 units, the maximum selling price is £160, the same selling price given in Example 11A.1. We shall now use differential calculus to derive the optimal selling price:

$$TC = £700\,000 + £70x$$
$$SP = £200 - £0.004x$$

Therefore total revenue (TR) for an output of x units = £200x – £0.004x^2

$$\text{marginal cost (MC)} = \frac{\text{dTC}}{\text{d}x} = £70$$

$$\text{marginal revenue (MR)} = \frac{\text{dTR}}{\text{d}x} = £200 - £0.008x$$

At the optimum output level

$$\frac{\text{dTC}}{\text{d}x} = \frac{\text{dTR}}{\text{d}x}$$

And so

$$£70 = £200 - £0.008x$$
$$x = 162\,500 \text{ units}$$

The highest selling price at which this output can be sold is

$$\text{SP} = £200 - £0.004\,(16\,250)$$

so

$$\text{SP} = £135$$

Thus optimum selling price and output are £135 and 16.250 units respectively.



Key terms and concepts

decision-relevant approach (p. 295)
differential cash flow (p. 296)
incremental cash flow (p. 296)
limiting factor (p. 302)
opportunity cost (p. 301)
outsourcing (p. 306)
qualitative factors (p. 297)
relevant cost (p. 296)
replacement cost (p. 313)
special studies (p. 295)
written-down value (p. 304)

Key examination points

A common mistake that students make when presenting information for decision-making is to compare *unit* costs. With this approach, there is a danger that fixed costs will be unitized and treated as variable costs. In most cases you should compare total amounts of costs and revenues rather than unit amounts. Many students do not present the information clearly and concisely. There are many alternative ways of presenting the information, but the simplest approach is to list future costs and revenues for each alternative in a format similar to Exhibit 11.1. You should exclude irrelevant items or ensure that the same amount for irrelevant items is included for

each alternative. To determine the amount to be entered for each alternative, you should ask yourself what difference it will make if the alternative is selected.

Never allocate common fixed costs to the alternatives. You should focus on how each alternative will affect future cash flows of the organization. Changes in the apportionment of fixed costs will not alter future cash flows of the company. Remember that if a resource is scarce, your analysis should recommend the alternative that yields the largest contribution per limiting factor. You should now attempt the Review problems and compare your answers with the solutions that are provided. These problems will test your understanding of a variety of decision problems that have been covered in Chapter 11.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. Cases that are relevant to the content of this chapter include Fleet Ltd and High Street Reproduction Furniture Ltd.

Review questions

11.1 What is a relevant cost? (*p. 296*)

11.2 Why is it important to recognize qualitative factors when presenting information for decision-making? Provide examples of qualitative factors. (*p. 297*)

11.3 What underlying principle should be followed in determining relevant costs for decision-making? (*p. 300*)

11.4 Explain what is meant by special pricing decisions. (*p. 297*)

11.5 Describe the important factors that must be taken into account when making special pricing decisions. (*p. 299*)

11.13 A company produces three products which have the following details:

	I Per unit	II Per unit	III Per unit
Direct materials (at £5/kg)	8 kg	5 kg	6 kg
Contribution per unit	£35	£25	£48
Contribution per kg of material	$4.375	£5	£8
Demand (excluding special contract) (units)	3000	5000	2000

The company must produce 1000 units of Product I for a special contract before meeting normal demand. Unfortunately there are only 35 000 kg of material available.

What is the optimal production plan?

	I	II	III
A	1000	4600	2000
B	1000	3000	2000
C	2875	—	2000
D	3000	2200	—

ACCA – Financial Information for Management

11.14 A company uses limiting factor analysis to calculate an optimal production plan given a scarce resource.

The following applies to the three products of the company:

Product	I £	II £	III £
Direct materials (at £6/kg)	36	24	15
Direct labour (at £10/hour)	40	25	10
Variable overheads (£2/hour)	8	5	2
	84	54	27
Maximum demand (units)	2000	4000	4000
Optimal production plan	2000	1500	4000

How many kg of material were available for use in production?

A 15 750 kg
B 28 000 kg
C 30 000 kg
D 38 000 kg

ACCA – Financial Information for Management

11.15 A company has just secured a new contract which requires 500 hours of labour.

There are 400 hours of spare labour capacity. The remaining hours could be worked as overtime at time and a half or labour could be diverted from the production of product X. Product X currently earns a contribution of £4 in two labour hours and direct labour is currently paid at a rate of £12 per normal hour.

11.13 A company produces three products which have the following details:

	I Per unit	II Per unit	III Per unit
Direct materials (at £5/kg)	8 kg	5 kg	6 kg
Contribution per unit	£35	£25	£48
Contribution per kg of material	$4.375	£5	£8
Demand (excluding special contract) (units)	3000	5000	2000

The company must produce 1000 units of Product I for a special contract before meeting normal demand. Unfortunately there are only 35 000 kg of material available.

What is the optimal production plan?

	I	II	III
A	1000	4600	2000
B	1000	3000	2000
C	2875	—	2000
D	3000	2200	—

ACCA – Financial Information for Management

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The following applies to the three products of the company:

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Variable overheads (£2/hour)	8	5	2
	84	54	27
Maximum demand (units)	2000	4000	4000
Optimal production plan	2000	1500	4000

How many kg of material were available for use in production?

A 15 750 kg
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ACCA – Financial Information for Management

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There are 400 hours of spare labour capacity. The remaining hours could be worked as overtime at time and a half or labour could be diverted from the production of product X. Product X currently earns a contribution of £4 in two labour hours and direct labour is currently paid at a rate of £12 per normal hour.

Which component(s), if any, should BB Limited consider buying in?

(a) Buy in all three components.
(b) Do not buy any.
(c) Buy in S and U.
(d) Buy in T only.

CIMA Stage 1

11.19 A company is considering accepting a one-year contract which will require four skilled employees. The four skilled employees could be recruited on a one-year contract at a cost of £40 000, per employee. The employees would be supervised by an existing manager who earns £60 000 per annum. It is expected that supervision of the contract would take 10% of the manager's time.

Instead of recruiting new employees, the company could retrain some existing employees who currently earn £30 000 per year. The training would cost £15 000 in total. If these employees were used they would need to be replaced at a total cost of £100 000.

The relevant labour cost of the contract is:

A £100 000
B £115 000
C £135 000
D £141 000
E £166 000

CIMA Stage 2

11.20 An engineering firm has surplus capacity and wishes to secure a short-term contract to supply components. It has decided to bid for a contract at a price which will just cover all relevant costs.

Which ONE of the following costs should be included in the calculation of the minimum price it can bid?

A The cost of a research project undertaken last year which has resulted in an improved method of manufacturing the components.
B The cost of hiring a supervisor to oversee the contract's progress.
C The cost of labour which will be transferred to the contract from another production line where it is currently idle.
D The depreciation charge on existing machinery owned by the firm which will be used to manufacture the components.

CIMA – Management Accounting Fundamentals

11.21 A company is considering the costs for a special order. The order would require 1250 kg of material D. This material is readily available and regularly used by the company. There are 265 kg of material D in stock which cost £795 last week. The current market price is £3.24 per kg.

Material D is normally used to make product X. Each unit of X requires 3 kg of material D and, if material D is costed at £3 per kg, each unit of X yields a contribution of £15.

The cost of material D to be included in the costing of the special order is nearest to

A £3990 B £4050 C £10 000 D £10 300

CIMA Management Accounting – Performance Management

11.22 Camden has three divisions. Information for the year ended 30 September is as follows:

	Division A £'000	Division B £'000	Division C £'000	Total £'000
Sales	350	420	150	920
Variable costs	280	210	120	610
Contribution	70	210	30	310
Fixed costs				262.5
Net profit				47.5

General fixed overheads are allocated to each division on the basis of sales revenue; 60% of the total fixed costs incurred by the company are specific to each division being split equally between them.

Using relevant costing techniques, which divisions should remain open if Camden wishes to maximize profits?

A A, B and C
B A and B only
C B only
D B and C only.

ACCA Paper 1.2 – Financial Information for Management

11.23 **Calculation of a minimum contract price to break even**

Mike Limited has been asked to quote a price for a one-off contract. Management have drawn up the following schedule:

	(£)
Contract price (cost plus 20%)	60 780
Costs:	
Material: V (300 kg at £10/kg)	3 000
I (1000 litres at £7/litre)	7 000
C (550 kg at £3/kg)	1 650
Labour: Department 1 (1500 hours at £8/hour)	12 000
Department 2 (2000 hours at £10/hour)	20 000
Overheads: absorbed on a budgeted labour hour basis (3500 hours at £2/labour hour)	7 000
Total costs	50 650

The following is also relevant:

Material V	The cost of £10 is the original purchase cost incurred some years ago. This material is no longer in use by the company and if not used in the contract then it would be sold for scrap at £3/kg.
Material I	This is in continuous use by the business. £7 is the historic cost of the material although current supplies are being purchased at £6.50.
Material C	Mike Limited has 300 kg of this material in stock and new supplies would cost £4/kg. If current stocks are not used for the contract then they would be used as a substitute for material Y in another production process costing £7/kg. 2 kg of C replaces 1 kg of Y.

Department 1	This department has spare labour capacity sufficient for the contract and labour would be retained.
Department 2	This department is currently working at full capacity. Mike Limited could get the men to work overtime to complete the contract paid at time and a half, or they could divert labour hours from the production of other units that currently average £3 contribution per labour hour.
Overheads	These are arbitrarily absorbed at a predetermined rate. There will be no incremental costs incurred.

Required:
Calculate the minimum contract price that Mike Limited could accept to break even using relevant costing techniques.

(10 marks)
ACCA – Financial Information for Management

11.24 Key/limiting factors

Due to a national wage agreement, you find that wage rates for skilled workers are to increase by 50% over the budget figures. There is a shortage of such skilled workers and it takes over a year to train new recruits adequately. The managing director has asked you for advice as to which order of priority on the product range would give best use of the skilled labour resources available. The cost of unskilled labour, of which there is no shortage, will go up by 20% over budget.

The original budget figures for the next period before allowing for the increase in labour cost detailed above, were:

Product	V	W	X	Y	Z
Maximum production in units	3000	4000	6000	7000	9000
Selling price per unit	£16	£15	£18	£15	£30
Variable costs per unit					
Material	3	5	4	7	6
Skilled labour £4 per hour	4	4	6	2	8
Unskilled labour £2 per hour	2	2	1	1	4

Variable overheads are recovered at the rate of £1 per labour hour. The skilled labour available amounts to 30 000 hours in the period and there are fixed costs of £22 800.

You are required to:

(a) calculate the product mix which would result in the maximum profit;

(12 marks)

(b) comment on the results of the revised budget.

(6 marks)
(Total 18 marks)
AAT

11.25 Acceptance of a special order

The production manager of your organization has approached you for some costing advice on project X, a one-off order from overseas that he intends to tender for. The costs associated with the project are as follows:

	(£)
Material A	4 000
Material B	8 000
Direct labour	6 000
Supervision	2 000
Overheads	12 000
	32 000

You ascertain the following:

(i) Material A is in stock and the above was the cost. There is now no other use for material A, other than the above project, within the factory and it would cost £1750 to dispose of. Material B would have to be ordered at the cost shown above.

(ii) Direct labour costs of £6000 relate to workers that will be transferred to this project from another project. Extra labour will need to be recruited to the other project at a cost of £7000.

(iii) Supervision costs have been charged to the project on the basis of 33⅓% of labour costs and will be carried out by existing staff within their normal duties.

(iv) Overheads have been charged to the project at the rate of 200% on direct labour.

(v) The company is currently operating at a point above break-even.

(vi) The project will need the utilization of machinery that will have no other use to the company after the project has finished. The machinery will have to be purchased at a cost of £10 000 and then disposed of for £5250 at the end of the project.

The production manager tells you that the overseas customer is prepared to pay up to a maximum of £30 000 for the project and a competitor is prepared to accept the order at that price. He also informs you the minimum that he can charge is £40 000 as the above costs show £32 000, and this does not take into consideration the cost of the machine and profit to be taken on the project.

Required:

(a) Cost the project for the production manager, clearly stating how you have arrived at your figures and giving reasons for the exclusion of other figures.

(12 marks)

(b) Write a report to the production manager stating whether the organization should go ahead with the tender for the project, the reasons why and the price, bearing in mind that the competitor is prepared to undertake the project for £30 000.

(8 marks)

Note: The project should only be undertaken if it shows a profit.

(c) State four non-monetary factors that should be taken into account before tendering for this project.

(2 marks)

(d) What would be your advice if you were told that the organization was operating below break-even point? Give reasons for your advice.

(3 marks)

(Total 25 marks)

AAT Cost Accounting and Budgeting

11.26 Decision on which of two mutually exclusive contracts to accept

A company in the civil engineering industry with headquarters located 22 miles from London undertakes contracts anywhere in the United Kingdom.

The company has had its tender for a job in north-east England accepted at £288 000 and work is due to begin in March. However, the company has also been asked to undertake a contract on the south coast of England. The price offered for this contract is £352 000. Both of the contracts cannot be taken simultaneously because of constraints on staff site management personnel and on plant available. An escape clause enables the company to withdraw from the contract in the north-east, provided notice is given before the end of November and an agreed penalty of £28 000 is paid.

The following estimates have been submitted by the company's quantity surveyor:

Cost estimates	North-east (£)	South coast (£)
Materials:		
In stock at original cost, Material X	21 600	
In stock at original cost, Material Y		24 800
Firm orders placed at original cost, Material X	30 400	
Not yet ordered – current cost, Material X	60 000	
Not yet ordered – current cost, Material Z		71 200
Labour – hired locally	86 000	110 000
Site management	34 000	34 000
Staff accommodation and travel for site management	6 800	5 600
Plant on site – depreciation	9 600	12 800
Interest on capital, 8%	5 120	6 400
Total local contract costs	253 520	264 800
Headquarters costs allocated at rate of 5% on total contract costs	12 676	13 240
	266 196	278 040
Contract price	288 000	352 000
Estimated profit	21 804	73 960

Notes:

1. X, Y and Z are three building materials. Material X is not in common use and would not realize much money if re-sold; however, it could be used on other contracts but only as a substitute for another material currently quoted at 10% less than the original cost of X. The price of Y, a material in common use, has doubled since it was purchased; its net realizable value if re-sold would be its new price less 15% to cover disposal costs. Alternatively it could be kept for use on other contracts in the following financial year.

2. With the construction industry not yet recovered from the recent recession, the company is confident that manual labour, both skilled and unskilled, could be hired locally on a sub-contracting basis to meet the needs of each of the contracts.
3. The plant which would be needed for the south coast contract has been owned for some years and £12 800 is the year's depreciation on a straight-line basis. If the north-east contract is undertaken, less plant will be required but the surplus plant will be hired out for the period of the contract at a rental of £6000.
4. It is the company's policy to charge all contracts with notional interest at 8% on estimated working capital involved in contracts. Progress payments would be receivable from the contractee.
5. Salaries and general costs of operating the small headquarters amount to about £108 000 each year. There are usually ten contracts being supervised at the same time.
6. Each of the two contracts is expected to last from March to February which, coincidentally, is the company's financial year.
7. Site management is treated as a fixed cost.

You are required, as the management accountant to the company,

(a) to present comparative statements to show the net benefit to the company of undertaking the more advantageous of the two contracts;

(12 marks)

(b) to explain the reasoning behind the inclusion in (or omission from) your comparative financial statements, of each item given in the cost estimates and the notes relating thereto.

(13 marks)
(Total 25 marks)
CIMA Stage 2 Cost Accounting

11.27 Deletion of a product

Blackarm Ltd makes three products and is reviewing the profitability of its product line. You are given the following budgeted data about the firm for the coming year.

Product	A	B	C
Sales (in units)	100 000	120 000	80 000
	(£)	(£)	(£)
Revenue	1 500 000	1 440 000	880 000
Costs:			
Material	500 000	480 000	240 000
Labour	400 000	320 000	160 000
Overhead	650 000	600 000	360 000
	1 550 000	1 400 000	760 000
Profit/(Loss)	(50 000)	40 000	120 000

The company is concerned about the loss on product A. It is considering ceasing production of it and switching the spare capacity of 100 000 units to Product C.

You are told:

(i) All production is sold.

(ii) 25% of the labour cost for each product is fixed in nature.

(iii) Fixed administration overheads of £900 000 in total have been apportioned to each product on the basis of units sold and are included in the overhead costs above. All other overhead costs are variable in nature.

(iv) Ceasing production of product A would eliminate the fixed labour charge associated with it and one-sixth of the fixed administration overhead apportioned to product A.

(v) Increasing the production of product C by 100 000 units would mean that the fixed labour cost associated with product C would double, the variable labour cost would rise by 20% and its selling price would have to be decreased by £1.50 in order to achieve the increased sales.

Required:

(a) Prepare a marginal cost statement for a unit of each product on the basis of:
(i) the original budget;
(ii) if product A is deleted.

(12 marks)

(b) Prepare a statement showing the total contribution and profit for each product group on the basis of:
(i) the original budget;
(ii) if product A is deleted.

(8 marks)

(c) Using your results from (a) and (b) advise whether product A should be deleted from the product range, giving reasons for your decision.

(5 marks)

(Total 25 marks)

AAT Cost Accounting and Budgeting

11.28 Calculations of an optimal selling price

A company manufactures a single product, product Y. It has documented levels of demand at certain selling prices for this product as follows:

Demand	Selling price per unit	Cost per unit
Units	£	£
1100	48	24
1200	46	21
1300	45	20
1400	42	19

Required:

Using a tabular approach, calculate the marginal revenues and marginal costs for product Y at the different levels of demand, and so determine the selling price at which the company profits are maximized.

(10 marks)

ACCA – Financial Information for Management



The application of linear programming to management accounting

12

In the previous chapter we considered how accounting information should be used to ensure that scarce resources are efficiently allocated. Using Example 11.2, we established that where a scarce resource exists, that has alternative uses, the contribution per unit should be calculated for each of these uses. The available capacity of this resource is then allocated to the alternative uses on the basis of the contribution per scarce resource.

Where more than one scarce resource exists, the optimum production programme cannot easily be established by the process described in the previous chapter. In such circumstances there is a need to resort to linear programming techniques to establish the optimum production programme. Our objective in this chapter is to examine how linear programming techniques can be applied to determine the optimum production programme in situations where more than one scarce resource exists. Throughout the chapter we shall assume that only two products are produced so that the optimum output can be determined using a two dimensional graph. Where more than two products are produced the optimal output cannot easily be determined using the graphical method. Instead, the optimal output can be determined using a non-graphical approach that is known as the **Simplex method**. For a description of the simplex method you should refer to Drury (2004, ch. 26).

LEARNING OBJECTIVES

After studying this chapter you should be able to:

- describe the situations when it may be appropriate to use linear programming;
- explain the circumstances when the graphical method can be used;
- use graphical linear programming to find the optimum output levels;
- calculate the opportunity cost (shadow price) of scarce resources and explain the meaning of these terms.

Linear programming is a topic that is often included in second level cost and management accounting courses but recently some professional accountancy examining bodies have incorporated this topic in first level courses. You should therefore check your course content to ascertain if you will need to read this chapter.

Linear programming

Linear programming is a powerful mathematical technique that can be applied to the problem of rationing limited facilities and resources among many alternative uses in such a way that the optimum benefits can be derived from their utilization. It seeks to find a feasible combination of output that will maximize or minimize the **objective function**. The objective function refers to the quantification of an objective, and usually takes the form of maximizing profits or minimizing costs. Linear programming may be used when relationships can be assumed to be linear and where an optimal solution does in fact exist.

To comply with the linearity assumption, it must be assumed that the contribution per unit for each product and the utilization of resources per unit are the same whatever quantity of output is produced and sold within the output range being considered. It must also be assumed that units produced and resources allocated are infinitely divisible. This means that an optimal plan that suggests we should produce 94.38 units is possible. However, it will be necessary to interpret the plan as a production of 94 units.

Let us now apply this technique to the problem outlined in Exhibit 12.1, where there is a labour restriction plus a limitation on the availability of materials and machine hours. The contributions per scarce resource are as follows:

	Product Y (£)	Product Z (£)
Labour	2.33 (£14/6 hours)	2.00 (£16/8 hours)
Material	1.75 (£14/8 units)	4.00 (£16/4 units)
Machine capacity	3.50 (£14/4 hours)	2.67 (£16/6 hours)

This analysis shows that product Y yields the largest contribution per labour and machine hour, and product Z yields the largest contribution per unit of scarce materials, but there is no clear indication of how the quantity of scarce resources should be allocated to each product. Linear programming should be used in such circumstances.

The procedure is, first, to formulate the problem algebraically, with Y denoting the number of units of product Y and Z the number of units of product Z that are manufactured by the company. Secondly, we must specify the objective function, which in this example is to maximize contribution (denoted by C), followed by the input constraints. We can now formulate the linear programming model as follows:

Maximize $C = 14Y + 16Z$ subject to
$8Y + 4Z \leq 3440$ (material constraint)
$6Y + 8Z \leq 2880$ (labour constraint)
$4Y + 6Z \leq 2760$ (machine capacity constraint)
$0 \leq Y \leq 420$ (maximum and minimum sales limitation)
$Z \geq 0$ (minimum sales limitation)

EXHIBIT 12.1

Multiple resource constraint problem

The LP company currently makes two products. The standards per unit of product are as follows:

Product Y	(£)	(£)	Product Z	(£)	(£)
Product Y			Product Z		
Standard selling price		110	Standard selling price		118
Less standard costs:			Less standard costs:		
Materials (8 units at £4)	32		Materials (4 units at £4)	16	
Labour (6 hours at £10)	60		Labour (8 hours at £10)	80	
Variable overhead (4 machine hours at £1)	4		Variable overhead (6 machine hours at £1)	6	
		96			102
Contribution		14	Contribution		16

During the next accounting period, the availability of resources are expected to be subject to the following limitations:

Labour	2880 hours
Materials	3440 units
Machine capacity	2760 hours

The marketing manager estimates that the maximum sales potential for product Y is limited to 420 units. There is no sales limitation for product Z. You are asked to advise how these limited facilities and resources can best be used so as to gain the optimum benefit from them.

In this model, 'maximize C' indicates that we wish to maximize contribution with an unknown number of units of Y produced, each yielding a contribution of £14 per unit, and an unknown number of units of Z produced, each yielding a contribution of £16. The labour constraint indicates that 6 hours of labour are required for each unit of product Y that is made, and 8 hours for each unit of product Z. Thus (6 hours × Y) + (8 hours × Z) cannot exceed 2880 hours. Similar reasoning applies to the other inputs.

Because linear programming is nothing more than a mathematical tool for solving constrained optimization problems, nothing in the technique itself ensures that an answer will 'make sense'. For example, in a production problem, for some very unprofitable product, the optimal output level may be a negative quantity, which is clearly an impossible solution. To prevent such non-sensical results, we must include a non-negativity requirement, which is a statement that all variables in the problem must be equal to or greater than zero. We must therefore add to the model in our example the constraint that Y *and* Z must be greater than or equal to zero, i.e. $Z \geq 0$ and $0 \leq Y \leq 420$. The latter expression indicates that sales of Y cannot be less than zero or greater than 420 units. The model can be solved graphically, or by the Simplex method. When no more than two products are manufactured, the graphical method can be used, but this becomes impracticable where more than two products are involved, and it is then necessary to resort to the Simplex method. For a description of the Simplex method you should refer to Drury (2004, ch. 26).

Graphical method

Taking the first *constraint for the materials* input $8Y + 4Z \leq 3440$ means that we can make a maximum of 860 units of product Z when production of product Y is zero. The 860 units is arrived at by dividing the 3440 units of materials by the 4 units of material required for each unit of product Z. Alternatively, a maximum of 430 units or product Y can be made (3440 units divided by 8 units of materials) if no materials are allocated to product Z. We can therefore state that

$$\text{when } Y = 0, Z = 860$$
$$\text{when } Z = 0, Y = 430$$

These items are plotted in Figure 12.1, with a straight line running from $Z = 0, Y = 430$ to $Y = 0, Z = 860$. Note that the vertical axis represents the number of units of Y produced and the horizontal axis the number of units of Z produced.

The area to the left of line $8Y + 4Z \leq 3440$ contains all possible solutions for Y and Z in this particular situation, and any point along the line connecting these two outputs represents the maximum combinations of Y and Z that can be produced with not more than 3440 units of materials. Every point to the right of the line violates the material constraint.

The *labour constraint* $6Y + 8Z \leq 2880$ indicates that if production of product Z is zero, then a maximum of 480 units of product Y can be produced (2880/6), and if the output of Y is zero then 360 units of Z (2880/8) can be produced. We can now draw a second line $Y = 480, Z = 0$ to $Y = 0, Z = 360$, and this is illustrated in Figure 12.2. The area to the left of line $6Y + 8Z \leq 2880$ in this figure represents all the possible solutions that will satisfy the labour constraint.

The *machine input constraint* is represented by $Z = 0, Y = 690$ and $Y = 0, Z = 460$, and the line indicating this constraint is illustrated in Figure 12.3. The area to the left of the line $4Y + 6Z \leq 2760$ in this figure represents all the possible solutions that will satisfy the machine capacity constraint.

The final constraint is that the *sales output* of product Y cannot exceed 420 units. This is represented by the line $Y \leq 420$ in Figure 12.4, and all the items below this line represent all the possible solutions that will satisfy this sales limitation.

It is clear that any solution that is to fit *all* the constraints must occur in the shaded area ABCDE in Figure 12.5, which represents Figures 12.1–12.4 combined together. The point must now be found within the shaded area ABCDE where the contribution C is the greatest. The maximum will occur at one of the corner points ABCDE. The objective function is $C = 14Y + 16Z$, and a random contribution value is chosen that will result in a line for the objective function falling within the area ABCDE.

If we choose a random total contribution value equal to £2240, this could be obtained from producing 160 units (£2240/£14) of Y at £14 contribution per unit or 140 units of Z (£2240/£16) at a contribution of £16 per unit. We can therefore draw a line $Z = 0, Y = 160$ to $Y = 0, Z = 140$. This is represented by the dashed line in Figure 12.5. Each point on the dashed line represents all the output combinations of Z and Y that will yield a total contribution of £2240. The dashed line is extended to the right until it touches the last corner of the boundary ABCDE. This is the optimal solution and is at point C, which indicates an output of 400 units of Y (contribution £5600) and 60 units of Z (contribution £960), giving a total contribution of £6560.

The logic in the previous paragraph is illustrated in Figure 12.6. The shaded area represents the feasible production area ABCDE that is outlined in Figure 12.5, and parallel lines represent possible contributions, which take on higher values as we move to the right. If we assume that the firm's objective is to maximize total contribution, it

FIGURE 12.1 *Constraint imposed by limitations of materials*

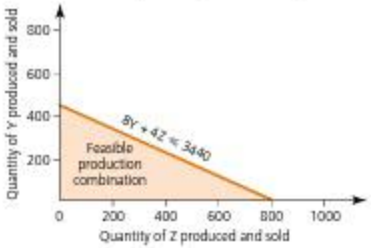


FIGURE 12.2 *Constraint imposed by limitations of labour*

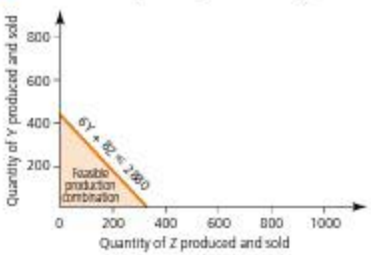


FIGURE 12.3 *Constraint imposed by machine capacity*

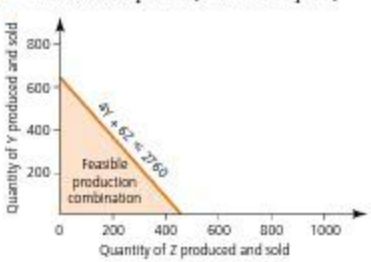


FIGURE 12.4 *Constraint imposed by sales limitation of product Y*

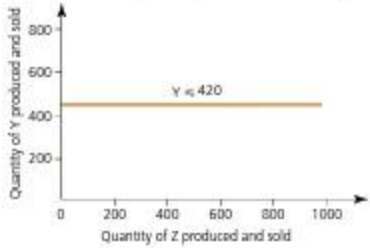
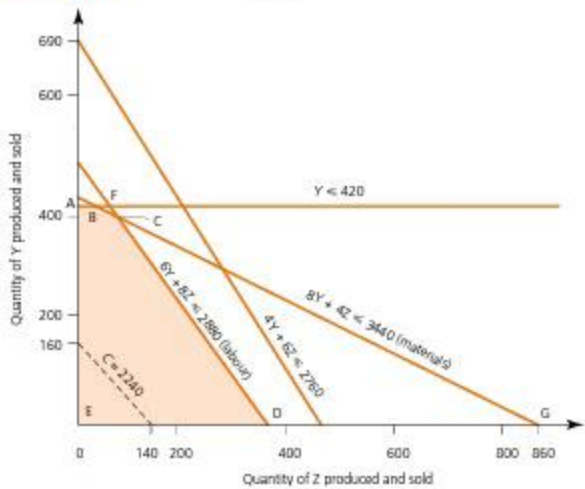
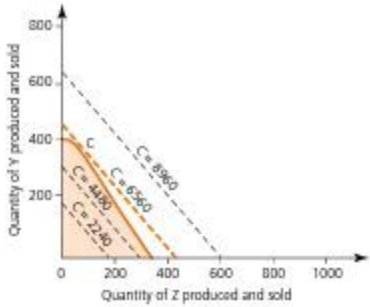


FIGURE 12.5 *Combination of Figures 12.1–12.4*



should operate on the highest contribution curve obtainable. At the same time, it is necessary to satisfy the production constraints, which are indicated by the shaded area in Figure 12.6. You will see that point C indicates the solution to the problem, since no other point within the feasible area touches such a high contribution line.

FIGURE 12.6 *Contribution levels from different potential combinations of products Y and Z*



It is difficult to ascertain from Figure 12.5 the exact output of each product at point C. The optimum output can be determined exactly by solving the simultaneous equations for the constraints that intersect at point C:

$$8Y + 4Z = 3440 \quad (12.1)$$
$$6Y + 8Z = 2880 \quad (12.2)$$

We can now multiply equation (12.1) by 2 and equation (12.2) by 1, giving

$$16Y + 8Z = 6880 \quad (12.3)$$
$$6Y + 8Z = 2880 \quad (12.4)$$

Subtracting equation (12.4) from equation (12.3) gives

$$10Y = 4000$$

and so

$$Y = 400$$

We can now substitute this value for Y onto equation (12.3), giving

$$(16 \times 400) + 8Z = 6880$$

and so

$$Z = 60$$



You will see from Figure 12.5 that the constraints that are binding at point C are materials and labour. It might be possible to remove these constraints and acquire additional labour and materials resources by paying a premium over and above the existing acquisition cost. How much should the company be prepared to pay? To answer this question, it is necessary to determine the optimal use from an additional unit of a scarce resource.

We shall now consider how the optimum solution would change if an additional unit of materials were obtained. You can see that if we obtain additional materials, the line $8Y + 4Z \leq 3440$ in Figure 12.5 will shift upwards and the revised optimum point will fall on line CF. If one extra unit of materials is obtained, the constraints $8Y + 4Z \leq 3440$ and $6Y + 8Z \leq 2880$ will still be binding, and the new optimum plan can be determined by solving the following simultaneous equations:

$$8Y + 4Z = 3441 \text{ (revised materials constraint)}$$
$$6Y + 8Z = 2880 \text{ (unchanged labour constraint)}$$

The revised optimal output when the above equations are solved is 400.2 units of Y and 59.85 units of Z. Therefore the planned output of product Y should be increased by 0.2 units, and planned production of Z should be reduced by 0.15 units. This optimal response from an independent marginal increase in a resource is called the **marginal rate of substitution**. The change in contribution arising from obtaining one additional unit of materials is as follows:

	(£)
Increase in contribution from Y (0.2 × £14)	2.80
Decrease in contribution of Z (0.15 × £16)	(2.40)
Increase in contribution	0.40

Therefore the value of an additional unit of materials is £0.40. The value of an independent marginal increase of scarce resource is called the **opportunity cost** or **shadow price**. You should note at this stage that for materials purchased in excess of 3440 units the company can pay up to £0.40 over and above the present acquisition cost of materials of £4 and still obtain a contribution towards fixed costs from the additional output.

From a practical point of view, it is not possible to produce 400.2 units of Y and 59.85 units of Z. Output must be expressed in single whole units. Nevertheless, the output from the model can be used to calculate the revised optimal output if additional units of materials are obtained. Assume that 100 additional units of materials can be purchased at £4.20 per unit from an overseas supplier. Because the opportunity cost (£0.40) is in excess of the additional acquisition cost of £0.20 per unit (£4.20 – £4), the company should purchase the extra materials. The marginal rates of substitution can be used to calculate the revised optimum output. The calculation is

Increase Y by 20 units (100 × 0.2 units)
Decrease Z by 15 units (100 × 0.15 units)

Therefore the revised optimal output is 420 outputs (400 + 20) of Y and 45 units (60 – 15) of Z.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Describe the situations when it may be appropriate to use linear programming.**

  Conventional limiting factor analysis (see Chapter 11) should be used when there is only one scarce factor. Linear programming can be used to determine the production programme that maximizes total contribution when there is more than one scarce input factor.

- **Explain the circumstances when the graphical method can be used.**

  The graphical method can be used with two products. Where more than two products are involved the simplex method should be used.

- **Use graphical linear programming to find the optimum output levels.**

  Production/sales quantities for one of the two products are labelled on the horizontal axis and the vertical axis is used for the other product. Combinations of the maximum output (based on the two products) from fully utilizing each resource, and any sales volume limitations, are plotted on the graph. A series of contribution lines are plotted based on the potential output levels for each product that will achieve a selected total contribution. The optimum output levels are derived at the point where the feasible production region touches the highest contribution line. The process is illustrated in Figures 12.5 and 12.6 using the data presented in Example 12.1.

- **Calculate the opportunity cost (shadow price) of scarce resources and explain the meaning of these terms.**

  The output from the linear programming model can be used to generate shadow prices (also known as opportunity costs) for each of those scarce resources that are fully utilized in the optimum production programme. The shadow prices represent the reduction in total contribution that will occur from the loss of one unit of a scarce resource. Conversely, they represent the increase in total contribution that will occur if an additional unit of the scarce resource can be obtained. The calculation of opportunity costs (shadow prices) was illustrated in the advanced reading section at the end of the chapter.



Key terms and concepts

linear programming (p. 332)
marginal rate of substitution (p. 338)
objective function (p. 332)
opportunity cost (p. 338)
shadow price (p. 338)
Simplex method (p. 331)

Key examination points

A common error is to state the objective function in terms of profit per unit. This is incorrect, because the fixed cost per unit is not constant. The objective function should be expressed in terms of contribution per unit where the objective is to maximize total contribution. Where the objective is to minimize costs, the objective function should be expressed in terms of variable cost per unit for each of the products produced.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

12.1 Describe the situations when it may be appropriate to use linear programming. (*pp. 331–2*)

12.2 Explain what is meant by the term 'objective function'. (*p. 332*)

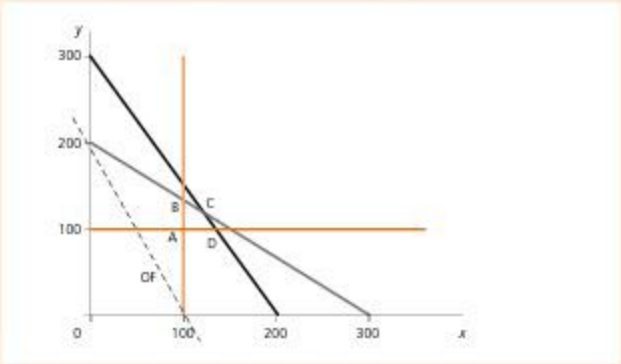
12.3 What is the feasible production area? (*p. 334*)

12.4 What is the marginal rate of substitution? (*p. 338*)

12.5 Explain what is meant by the term 'shadow price'. (*p. 338*)

Review problems

12.6 The following graph has been established for a given set of constraints:



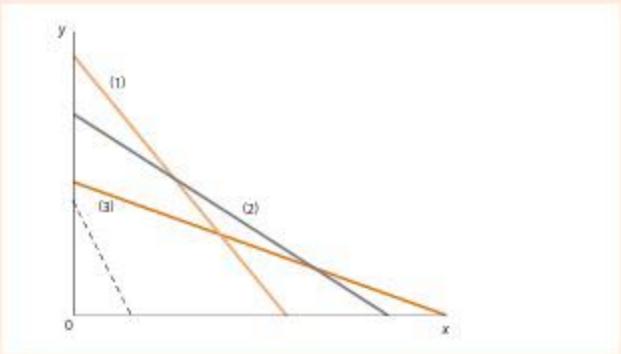
The objective function (OF) for the company has also been plotted on the graph and the feasible region is bounded by the area ABCD.

At which point on the graph will profits be maximized?

A
B
C
D

ACCA – Financial Information for Management

12.7 The following graph relates to a linear programming problem:



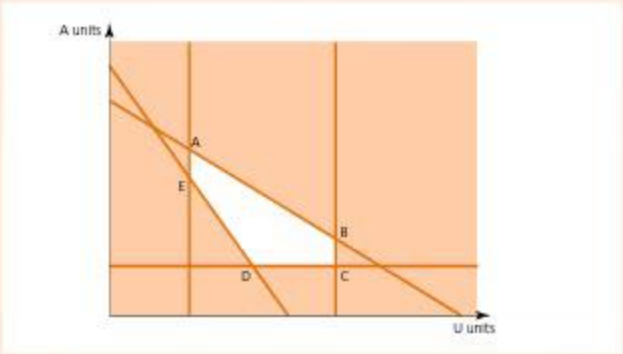
The objective is to maximize contribution and the dotted line on the graph depicts this function. There are three constraints which are all of the 'less than or equal to' type which are depicted on the graph by the three solid lines labelled (1), (2) and (3).

At which of the following intersections is contribution maximized?

A Constraints (1) and (2)
B Constraints (2) and (3)
C Constraints (1) and (3)
D Constraint (1) and the x-axis

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12.8 Taree Limited uses linear programming to establish the optimal production plan for the production of its two products, A and U, given that it has the objective of minimizing costs. The following graph has been established bearing in mind the various constraints of the business. The clear area indicates the feasible region.



Which points are most likely to give the optimal solution?

A A and B only
B A, B and C only
C D and E only
D B, D and E only.

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12.9 A company uses linear programming to establish an optimal production plan in order to maximize profit.

The company finds that the next year materials and labour are likely to be in short supply.

Details of the company's products are as follows:

	A £	B £
Materials (at £2 per kg)	6	8
Labour (at £6 per hour)	30	18
Variable overheads (at £1 per hour)	5	3
Variable cost	41	29
Selling price	50	52
Contribution	9	23

There are only 30 000 kg of material and 36 000 labour hours available. The company also has an agreement to supply 1000 units of product A which must be met.

Required:

(a) Formulate the objective function and constraint equations for this problem. *(4 marks)*

(b) Plot the constraints on a suitable graph and determine the optimal production plan.

(6 marks)

ACCA – Financial Information for Management

12.10 Optimal output and calculation of shadow prices using graphical approach

Brass Ltd produces two products, the Masso and the Russo. Budgeted data relating to these products on a unit basis for August are as follows:

	Masso (£)	Russo (£)
Selling price	150	100
Materials	80	30
Salesmen's commission	30	20

Each unit of product incurs costs of machining and assembly. The total capacity available in August is budgeted to be 700 hours of machining and 1000 hours of assembly, the cost of this capacity being fixed at £7000 and £10 000 respectively for the month, whatever the level of usage made of it. The number of hours required in each of these departments to complete one unit of output is as follows:

	Masso	Russo
Machining	1.0	2.0
Assembly	2.5	2.0

Under the terms of special controls recently introduced by the Government in accordance with EEC requirements, selling prices are fixed and the maximum permitted output of either product in August is 400 units (i.e. Brass Ltd may

produce a maximum of 800 units of product). At the present controlled selling prices the demand for the products exceeds this considerably.

You are required:

(a) to calculate Brass Ltd's optimal production plan for August, and the profit earned,

(10 marks)

(b) to calculate the value to Brass Ltd of an independent marginal increase in the available capacity for each of machining and assembly, assuming that the capacity of the other department is not altered and the output maxima continue to apply,

(10 marks)

(c) to state the principal assumptions underlying your calculations in (a) above, and to assess their general significance.

(5 marks)

ICAEW Management Accounting



Activity-based costing

13

The aim of Chapter 11 was to provide you with an understanding of the principles that should be used to identify relevant costs and revenues for various types of decisions. It was assumed that relevant costs could easily be measured but, in reality, it was pointed out that indirect relevant costs can be difficult to identify and measure. The measurement of indirect relevant costs for decision-making using activity-based costing (ABC) techniques will be examined in this chapter. The aims of this chapter are to provide you with a conceptual understanding of ABC and explain how an ABC system operates.

Unless otherwise stated we shall assume that products are the cost objects but the techniques used, and the principles established, can also be applied to other cost objects such as customers, services and locations. We begin with an examination of the role that a cost accumulation system plays in generating relevant cost information for decision-making.

You should note that this chapter extends the material covered in Chapter 4. To understand the content of this chapter it is essential that you thoroughly understand the content of Chapter 4. You are therefore recommended to refresh your memory of the material covered in Chapter 4 and read pages 92–102 prior to reading this chapter.

LEARNING OBJECTIVES

After studying this chapter you should be able to:

- explain why a cost accumulation system is required for generating relevant cost information for decision-making;
- describe the differences between activity-based and traditional costing systems;
- explain why traditional costing systems can provide misleading information for decision-making;
- compute product costs using an ABC system;
- identify and explain each of the four stages involved in designing ABC systems;
- describe the ABC cost hierarchy.

Finally, ABC is an advanced topic and may not be included as part of your course curriculum. You should check your course content to ascertain if you will need to read this chapter.

The need for a cost accumulation system in generating relevant cost information for decision-making

If a cost accumulation system that assigns indirect costs to cost objects is not established there is a danger that only those incremental costs that are uniquely attributable to individual products will be classified as relevant and indirect costs will be classified as irrelevant for decision-making. Direct costs are transparent and how they will be affected by decisions is clearly observable. In contrast, how indirect costs will be affected by decisions is not clearly observable. There has been a tendency in the past to assume that these costs are fixed and irrelevant for decision-making. In many organizations, however, these are costs that have escalated over the years. The message is clear – they cannot be assumed to be fixed and irrelevant for decision-making.

Many indirect costs fluctuate in the long term according to the demand for them. The cost of support functions falls within this category. They include activities such as materials procurement, materials handling, production scheduling, warehousing, expediting and customer order processing. The costs of these activities are either not directly traceable to products, or would involve such detailed tracing that the costs of doing so would far exceed their benefits. Product introduction, discontinuation, redesign and mix decisions determine the demand for support function resources. For example, if a decision results in a 10% reduction in the demand for the resources of a support activity then we would expect, in the long term, some of the costs of that support activity to decline by 10%. Therefore, to estimate the impact that decisions will have on the support activities (and their future costs) a cost accumulation system is required that assigns those indirect costs, using cause-and-effect allocations, to products.

Types of cost systems

Costing systems can vary in terms of which costs are assigned to cost objects and their level of sophistication. Typically cost systems are classified as follows:

1. direct costing systems;
2. traditional absorption costing systems;
3. activity-based costing systems.

Direct costing systems (see Chapter 8) only assign direct costs to cost objects. Because they do not assign indirect costs to cost objects they report contributions to indirect costs. Direct costing systems can therefore be classified as partial costing systems. They are appropriate for decision-making where indirect costs that fluctuate according to the demand for them are insignificant. Negative or low contribution items should then be highlighted for special studies. An estimate of those indirect costs that are relevant to the decision should be incorporated within the analysis at the special study stage. The disadvantage of direct costing systems is that systems are not in place to measure and assign indirect costs to cost objects. Thus any attempt to incorporate indirect costs into the analysis at the special studies stage must be based on guesswork and arbitrary

estimates. Direct costing systems can therefore only be recommended where indirect costs are a low proportion of an organization's total costs.

Both traditional and ABC systems assign indirect costs to cost objects. The major features of traditional systems were described in Chapter 4. In this chapter we shall concentrate on ABC systems.

A comparison of traditional and ABC systems

Figure 13.1 illustrates the major differences between traditional costing and ABC systems. The upper panel of this diagram is identical to Figure 4.3, used in Chapter 4 to describe a traditional costing system. It is apparent from Figure 13.1 that both systems involve the two-stage allocation process. In the first stage a traditional system allocates overheads to production and service departments and then reallocates service department costs to the production departments. An ABC system assigns overheads to each major activity (rather than departments). With ABC systems, many activity-based cost centres (alternatively known as activity cost pools) are established, whereas with traditional systems overheads tend to be pooled by departments, although they are normally described as cost centres.

Activities consist of the aggregation of many different tasks and are described by verbs associated with objects. Typical support activities include: schedule production, set-up machines, move materials, purchase materials, inspect items, process supplier records, expedite and process customer orders. Production process activities include machine products and assemble products. Within the production process, activity cost centres are often identical to the cost centres used by traditional cost systems. Support activities are also sometimes identical to cost centres used by traditional systems, such as when the purchasing department and activity are both treated as cost centres. Overall, however, ABC systems will normally have a greater number of cost centres.

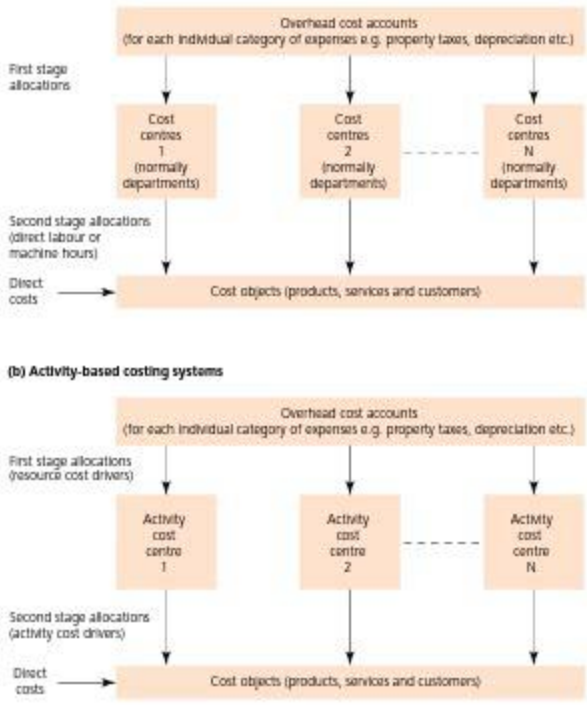
The second stage of the two-stage allocation process allocates costs from cost centres (pools) to products or other chosen cost objects. Traditional costing systems trace overheads to products using a small number of second stage allocation bases (normally described as overhead allocation rates), which vary directly with the volume produced. Instead of using the terms 'allocation bases' or 'overhead allocation rates' the term **'cost driver'** is used by ABC systems. Direct labour and machine hours are the allocation bases that are normally used by traditional costing systems. In contrast, ABC systems use many different types of second-stage cost drivers, including non-volume-based drivers, such as the number of production runs for production scheduling and the number of purchase orders for the purchasing activity. A further distinguishing feature is that traditional systems normally allocate service/support costs to production centres. Their costs are merged with the production cost centre costs and thus included within the production centre overhead rates. In contrast, ABC systems tend to establish separate cost driver rates for support centres, and assign the cost of support activities directly to cost objects without any reallocation to production centres.

Therefore the major distinguishing features of ABC systems are that within the two-stage allocation process they rely on:

1. a greater number of cost centres;
2. a greater number and variety of second stage cost drivers.

By using a greater number of cost centres and different types of cost drivers that cause activity resource consumption, and assigning activity costs to cost objects on the basis of cost driver usage, ABC systems can more accurately measure the resources

FIGURE 13.1 *An illustration of the two-stage allocation process for traditional and activity-based costing systems*



consumed by cost objects. Traditional cost systems report less accurate costs because they use cost drivers where no cause-and-effect relationships exist to assign support costs to cost objects.

The emergence of ABC systems

During the 1980s the limitations of traditional product costing systems began to be widely publicized. These systems were designed decades ago when most companies

manufactured a narrow range of products, and direct labour and materials were the dominant factory costs. Overhead costs were relatively small, and the distortions arising from inappropriate overhead allocations were not significant. Information processing costs were high, and it was therefore difficult to justify more sophisticated overhead allocation methods.

Today companies produce a wide range of products; direct labour represents only a small fraction of total costs, and overhead costs are of considerable importance. Simplistic overhead allocations using a declining direct labour base cannot be justified, particularly when information processing costs are no longer a barrier to introducing more sophisticated cost systems. Furthermore, the intense global competition of the 1980s has made decision errors due to poor cost information more probable and more costly. Over the years the increased opportunity cost of having poor cost information, and the decreased cost of operating more sophisticated cost systems, increased the demand for more accurate product costs (Holzer and Norreklit, 1991). It is against this background that ABC has emerged.

Decreasing information processing costs resulted in a few firms in the USA and Europe implementing ABC-type systems during the 1980s. In a series of articles based on observations of innovative ABC-type systems Cooper and Kaplan conceptualized the ideas underpinning these systems and coined the term ABC. These articles were first published in 1988. They generated a considerable amount of publicity and consultants began to market and implement ABC systems before the end of the decade. In a survey of UK companies Innes and Mitchell (1991) reported that approximately 10% of the surveyed companies had implemented, or were in the process of implementing ABC. Based on their experience of working with early US adopters, Cooper and Kaplan articulated their ideas and reported further theoretical advances in articles published between 1990 and 1992. These ideas and the theoretical advances are described in the remainder of this chapter. ABC ideas have now become firmly embedded in the management accounting literature and educational courses.

Volume-based and non-volume-based cost drivers

Our comparison of ABC systems with traditional costing systems indicated that ABC systems rely on a greater number and variety of second stage cost drivers. The term 'variety of cost drivers' refers to the fact that ABC systems use both volume-based and non-volume-based cost drivers. In contrast, traditional systems use only volume-based cost drivers. **Volume-based cost drivers** assume that a product's consumption of overhead resources is directly related to units produced. In other words, they assume that the overhead consumed by products is highly correlated with the number of units produced. Typical volume-based cost drivers used by traditional systems are units of output, direct labour hours and machine hours. These cost drivers are appropriate for measuring the consumption of expenses such as machine energy costs, depreciation related to machine usage, indirect labour employed in production centres and inspection costs where each item produced is subject to final inspection. For example, machine hours are an appropriate cost driver for energy costs since if volume is increased by 10%, machine hours are likely to increase by 10%, thus causing 10% more energy costs to be consumed. Similarly, an increase in volume of 10% is likely to increase the consumption of direct labour hours by 10% and, assuming that indirect labour hours are correlated with direct labour hours, 10% more indirect labour costs will be consumed.

Volume-based drivers are appropriate in the above circumstances because activities are performed each time a unit of the product or service is produced. In contrast,

non-volume related activities are not performed each time a unit of the product or service is produced. Consider, for example, the activity of setting up a machine. Set-up resources are consumed each time a machine is changed from one product to another. It costs the same to set-up a machine for 10 or 5000 items. As more set-ups are done more set-up resources are consumed. The number of set-ups, rather than the number of units produced, is a more appropriate measure of the consumption of the set-up activity. For this activity, a **non-volume-based cost driver** such as number of set-ups is needed for the accurate assignment of the costs.

Using only volume-based cost drivers to assign non-volume related overhead costs can result in the reporting of distorted product costs. The extent of distortion depends on what proportion of total overhead costs the non-volume-based overheads represent and the level of product diversity. If a large proportion of an organization's costs are unrelated to volume there is danger that inaccurate product costs will be reported. Conversely, if non-volume-related overhead costs are only a small proportion of total overhead costs, the distortion of product costs will not be significant. In these circumstances traditional product costing systems are likely to be acceptable.

Product diversity applies when products consume different overhead activities in dissimilar proportions. Differences in product size, product complexity, sizes of batches and set-up times cause product diversity. If all products consume overhead resources in similar proportions product diversity will be low and products will consume non-volume-related activities in the same proportion as volume-related activities. Hence, product cost distortion will not occur with traditional product costing systems. Two conditions are therefore necessary for product cost distortion – non-volume-related overhead costs are a large proportion of total overhead costs and product diversity applies. Where these two conditions exist traditional product costing systems can result in the overcosting of high volume products and undercosting of low volume products. Consider the information presented in Example 13.1.

The reported product costs and profits for the two products are as follows:

	Traditional system		ABC system	
	Product HV (£)	Product LV (£)	Product HV (£)	Product LV (£)
Direct costs	310 000	40 000	310 000	40 000
Overheads allocated[a]	300 000 (30%)	50 000 (5%)	150 000 (15%)	150 000 (15%)
Reported profits/(losses)	(10 000)	60 000	140 000	(40 000)
Sales revenues	600 000	150 000	600 000	150 000

Note

[a]Allocation of £1 million overheads using direct labour hours as the allocation base for the traditional system and number of batches processed as the cost driver for the ABC system.

Because product HV is a high volume product that consumes 30% of the direct labour hours whereas product LV, the low volume product consumes only 5%, the traditional system that uses direct labour hours as the allocation base allocates six times more overheads to product HV. However, ABC systems recognize that overheads are caused by other factors, besides volume. In our example, all of the overheads are assumed to be volume-unrelated. They are caused by the number of batches processed and the ABC system establishes a cause-and-effect allocation relationship by using the number of batches processed as the cost driver. Both products require 15% of the total number of batches so they are allocated with an equal amount of overheads.

EXAMPLE 13.1

Assume that the Balearic company has only one overhead cost centre or cost pool. It currently operates a traditional costing system using direct labour hours to allocate overheads to products. The company produces several products, two of which are products HV and LV. Product HV is made in high volumes whereas product LV is made in low volumes. Product HV consumes 30% of the direct labour hours and product LV consumes only 5%. Because of the high-volume production product HV can be made in large production batches but the irregular and low level of demand for product LV requires it to be made in small batches. A detailed investigation indicates that the number of batches processed causes the demand for overhead resources. The traditional system is therefore replaced with an ABC system using the number of batches processed as the cost driver. You ascertain that each product accounts for 15% of the batches processed during the period and the overheads assigned to the cost centre that fluctuate in the long term according to the demand for them amount to £1 million. The direct costs and sales revenues assigned to the products are as follows:

	Product HV (£)	Product LV (£)
Direct costs	310 000	40 000
Sales revenues	600 000	150 000

Show the product profitability analysis for products HV and LV using the traditional and ABC systems.

It is apparent from the consumption ratios of the two products that the traditional system based on direct labour hours will overcost high volume products. **Consumption ratios** represent the proportion of each activity consumed by a product. The consumption ratios if direct labour hours are used as the cost driver are 0.30 for product HV and 0.05 for product LV so that six times more overheads will be assigned to product HV. When the number of batches processed are used as the cost driver the consumption ratios are 0.15 for each product and an equal amount of overhead will be assigned to each product. Distorted product costs are reported with the traditional costing system that uses the volume-based cost driver because the two conditions specified above apply. First, non-volume-related overheads are a large proportion of total overheads, being 100% in our example. Second, product diversity exists because the product consumption ratios for the two identified cost drivers are significantly different. Our illustration shows that if the consumption ratios for batches processed had been the same as the ratios for direct labour the traditional and ABC systems would report identical product costs.

With the traditional costing system misleading information is reported. A small loss is reported for product HV and if it were discontinued the costing system mistakenly gives the impression that overheads will decline in the longer term by £300 000. Furthermore, the message from the costing system is to concentrate on the more profitable speciality products like product LV. In reality this strategy would be disastrous because low volume products like product LV are made in small batches and require more people for scheduling production, performing set-ups, inspection of the batches



The shift in the assignment of overhead costs at Hewlett-Packard

A division of Hewlett-Packard that manufactures electronic circuit boards faced an environment that conformed closely to the conditions for which ABC is recommended:

- diverse products;
- relatively high overhead costs and for some products, higher than the direct costs;
- production volumes that vary significantly among products;
- the belief by the operating managers that the old traditional system did not give meaningful product costs.

An ABC system was introduced consisting of ten different cost pools and drivers. The composition of the cost pools and selection of the most appropriate drivers resulted from an intense analysis of the production process and cost behaviour patterns. When the company implemented ABC the costs of the old and new system were compared. One circuit board that would have been assigned with overheads of $5 with the old system had a reported total cost of $25 with ABC – an increase of 400%. Another circuit board that would have been assigned an overhead of $123 with the old system was assigned $45 with ABC.

During a six-month forecast and budget cycle, the ABC system resulted in shifting millions of dollars of costs between customers and products and thus had a dramatic impact on product design and pricing decisions.

Source: Merz, M. and Hardy, A. (1993), ABC puts accountants on the design team at HP, *Management Accounting (USA)*, September, pp. 24–6.

and handling a large number of customer requests for small orders. The long-term effect would be escalating overhead costs.

In contrast, the ABC system allocates overheads on a cause-and-effect basis and more accurately measures the relatively high level of overhead resources consumed by product LV. The message from the profitability analysis is the opposite from the traditional system; that is, product HV is profitable and product LV is unprofitable. If product LV is discontinued, and assuming that the cost driver is the cause of all the overheads then a decision to discontinue product LV should result in the reduction in resource spending on overheads by £150 000.

Example 13.1 is very simplistic. It is assumed that the organization has established only a single cost centre or cost pool, when in reality many will be established with a traditional system, and even more with an ABC system. Furthermore, the data have been deliberately biased to show the superiority of ABC. The aim of the illustration has been to highlight the potential cost of errors that can occur when information extracted from simplistic and inaccurate cost systems is used for decision-making.

An illustration of the two-stage process for an ABC system



We shall now use the data presented in Example 4.1 (the Enterprise Company) from Chapter 4 to illustrate ABC in more detail. This example was used to provide the relevant information to compute the overhead rates shown in Exhibit 4.2 for a traditional costing system. To refresh your memory, and to enable you to compare traditional and ABC systems, you should now refer back to Chapter 4 and read pages 92–102 relating to the two-stage allocation process for a traditional costing system. Example 4.1 and Exhibit 4.2 are now repeated so that you do not have to be constantly referring back to Chapter 4.

With the ABC system it is assumed that the activity cost centres for machining and assembling products are identical to the production cost centres used by the traditional costing system. We shall also assume that three activity cost centres have been established for each of the support functions. They are purchasing components, receiving components and disbursing materials for the materials procurement function and production scheduling, setting-up machines and a quality inspection of the completed products for the general factory support function. Exhibit 13.1 provides the additional information required for an ABC system and also shows the activity-based product cost calculations.

If you refer to column 2 in the upper section of Exhibit 13.1 you will see that the costs assigned to the production activities have been extracted from row 1 in the overhead analysis sheet shown in Exhibit 4.2, that was used for the traditional costing system to the materials procurement and the general factory support functions, and not to the activities within these support functions. However, the costs for the activities within these functions would be derived adopting the same approach as that used in Exhibit 4.2, but to simplify the presentation the cost assignments to the individual activity cost centres within the material procurement and general factory support functions are not shown.

Exhibit 13.1 shows the product cost calculations for an ABC system. By referring to the second column in the upper section of this exhibit you will see that the costs assigned to the purchasing, receiving and disbursement of materials activities total £1 760 000, the same as the total allocated to the materials procurement function by the traditional system shown in Exhibit 4.2. Similarly, the total costs assigned to the production scheduling, set-up and quality inspection activities in column 2 of the upper section of Exhibit 13.1 total £1 800 000, the same as the total costs allocated to the general factory support function in Exhibit 4.2.

Now look at columns 1 and 3 in the upper section of Exhibit 13.1. You will see that with the ABC system the Enterprise Company has established nine activity cost centres and seven different second-stage cost drivers. Note also that the cost drivers for the production activities are the same of those used for the traditional costing system. Based on their observations of ABC systems Kaplan and Cooper (1998) suggest that relatively simple ABC systems having 30–50 activity cost centres and many cost drivers ought to report reasonably accurate costs.

To emphasize the point that ABC systems use cause-and-effect second stage allocations the term cost driver tends to be used instead of allocation base. Cost drivers should be significant determinants of the cost of activities. For example, if the cost of processing purchase orders is determined by the number of purchase orders that each product generates, then the number of purchase orders would represent the cost driver for the cost of processing purchase orders. Other cost

EXAMPLE 4.1
(from Chapter 4)

The annual overhead costs for the Enterprise Company which has three production centres (two machine centres and one assembly centre) and two service centres (materials procurement and general factory support) are as follows:

	(£)	(£)
Indirect wages and supervision		
Machine centres: X	1 000 000	
Y	1 000 000	
Assembly	1 500 000	
Materials procurement	1 100 000	
General factory support	1 480 000	6 080 000
Indirect materials		
Machine centres: X	500 000	
Y	805 000	
Assembly	105 000	
Materials procurement	0	
General factory support	10 000	1 420 000
Lighting and heating	500 000	
Property taxes	1 000 000	
Insurance of machinery	150 000	
Depreciation of machinery	1 500 000	
Insurance of buildings	250 000	
Salaries of works management	800 000	4 200 000
		11 700 000

The following information is also available:

	Book value of machinery (£)	Area occupied (sq. metres)	Number of employees	Direct labour hours	Machine hours
Machine shop: X	8 000 000	10 000	300	1 000 000	2 000 000
Y	5 000 000	5 000	200	1 000 000	1 000 000
Assembly	1 000 000	15 000	300	2 000 000	
Stores	500 000	15 000	100		
Maintenance	500 000	5 000	100		
	15 000 000	50 000	1000		

Details of total materials issues (i.e. direct and indirect materials) to the production centres are as follows:

	£
Machine shop X	4 000 000
Machine shop Y	3 000 000
Assembly	1 000 000
	8 000 000

EXHIBIT 4.2

Overhead analysis sheet (from Chapter 4)

		Production centres				Service centres	
Item of expenditure	Basis of allocation	Total (£)	Machine centre X (£)	Machine centre Y (£)	Assembly (£)	Materials procurement (£)	General factory support (£)
Indirect wage and supervision	Direct	6 080 000	1 000 000	1 000 000	1 500 000	1 100 000	1 480 000
Indirect materials	Direct	1 420 000	500 000	805 000	105 000		10 000
Lighting and heating	Area	500 000	100 000	50 000	150 000	150 000	50 000
Property taxes	Area	1 000 000	200 000	100 000	300 000	300 000	100 000
Insurance of machinery	Book value of machinery	150 000	80 000	50 000	10 000	5 000	5 000
Depreciation of machinery	Book value of machinery	1 500 000	800 000	500 000	100 000	50 000	50 000
Insurance of buildings	Area	250 000	50 000	25 000	75 000	75 000	25 000
Salaries of works management	Number of employees	800 000	240 000	160 000	240 000	80 000	80 000
	(1)	11 700 000	2 970 000	2 690 000	2 480 000	1 760 000	1 800 000
Reallocation of service centre costs							
Materials procurement	Value of materials issued	—	880 000	660 000	220 000	1 760 000	
General factory support	Direct labour hours	—	450 000	450 000	900 000		1 800 000
	(2)	11 700 000	4 300 000	3 800 000	3 600 000	—	—
Machine hours and direct labour hours		2 000 000	1 000 000	2 000 000			
Machine hour overhead rate			£2.15	£3.80			
Direct labour hour overhead rate					£1.80		

EXHIBIT 13.1

An illustration of cost assignment with an ABC system

(1) Activity	(2) Activity cost £	(3) Activity cost driver	(4) Quantity of activity cost driver	(5) Activity cost driver rate (Col. 2/Col.4)
Production activities:				
Machining: activity centre A	2 970 000	Number of machine hours	2 000 000 machine hours	£1.485 per hour
Machining: activity centre B	2 690 000	Number of machine hours	1 000 000 machine hours	£2.69 per hour
Assembly	2 480 000	Number of direct labour hours	2 000 000 direct lab. hours	£1.24 per hour
	8 140 000			
Materials procurement activities:				
Purchasing components	960 000	Number of purchase orders	10 000 purchase orders	£96 per order
Receiving components	600 000	Number of material receipts	5 000 receipts	£120 per receipt
Disburse materials	200 000	Number of production runs	2 000 production runs	£100 per production run
	1 760 000			
General factory support activities:				
Production scheduling	1 000 000	Number of production runs	2 000 production runs	£500 per production run
Set-up machines	600 000	Number of set-up hours	12 000 set-up hours	£50 per set-up hour
Quality inspection	200 000	Number of first item inspections	1 000 inspections	£200 per inspection
	1 800 000			
Total cost of all manufacturing activities	11 700 000			

Computation of product costs

(1) Activity	(2) Activity cost driver rate	(3) Quantity of cost driver used by 100 units of product A	(4) Quantity of cost driver used by 200 units of product B	(5) Activity cost assigned to product A (Col. 2 × Col. 3)	(6) Activity cost assigned to product B (Col. 2 × Col. 4)
Machining: activity centre A	£1.485 per hour	500 hours	2 000 hours	742.50	2 970.00
Machining: activity centre B	£2.69 per hour	1 000 hours	4 000 hours	2 690.00	10 760.00
Assembly	£1.24 per hour	1 000 hours	4 000 hours	1 240.00	4 960.00
Purchasing components	£96 per order	1 component	1 component	96.00	96.00
Receiving components	£120 per receipt	1 component	1 component	120.00	120.00
Disburse materials	£100 per production run	5 production runs*	1 production run	500.00	100.00
Production scheduling	£500 per production run	5 production runs*	1 production run	2 500.00	500.00
Set-up machines	£50 per set-up hour	50 set-up hours	10 set-up hours	2 500.00	500.00
Quality inspection	£200 per inspection	1 inspection	1 inspection	200.00	200.00
Total overhead cost				10 588.50	20 206.00
Units produced				100 units	200 units
Overhead cost *per unit*				£105.88	£101.03
Direct costs *per unit*				100.00	200.00
Total cost *per unit* of output				205.88	301.03

Note

* Five production runs are required to machine several unique components before they can be assembled into a final product.

drivers used by the Enterprise Company are shown in column 3 of Exhibit 13.1. They are the number of receipts for receiving components, number of production runs for disbursing materials and scheduling production, number of set-up hours for setting up the machines and the number of first item inspections for quality inspection of a batch of completed products. You will see from column 5 in the first section of Exhibit 13.1 that cost driver rates are computed by dividing the activity centre cost by the quantity of the cost driver used.

Activity centre costs are assigned to products by multiplying the cost driver rate by the quantity of the cost driver used by products. These calculations are shown in the second section of Exhibit 13.1. You will see from the first section in Exhibit 13.1 that the costs assigned to the purchasing activity are £960 000 for processing 10 000 purchasing orders resulting in a cost driver rate of £96 per purchasing order. The second section shows that a batch of 100 units of product A, and 200 units of product B, each require one purchased component and thus one purchase order. Therefore purchase order costs of £96 are allocated to each batch. The same approach is used to allocate the costs of the remaining activities shown in Exhibit 13.1. You should now work through Exhibit 13.1 and study the product cost calculations.

The costs assigned to products using each costing system are as follows:

	Traditional costing system £	ABC system £
Product A	166.75[a]	205.88
Product B	333.50[a]	301.03

Note

[a]Please refer to pages 101–2 in Chapter 4 for the calculations of the product costs for the traditional costing system.

Compared with the ABC system the traditional system undercosts product A and overcosts product B. By reallocating the service centre costs to the production centres and allocating the costs to products on the basis of either machine hours or direct labour hours the traditional system incorrectly assumes that these allocation bases are the cause of the costs of the support activities. Compared with product A, product B consumes twice as many machine and direct labour hours per unit of output. Therefore, relative to Product A, the traditional costing system allocates twice the amount of support costs to product B.

In contrast, ABC systems create separate cost centres for each major support activity and allocates costs to products using cost drivers that are the significant determinants of the cost of the activities. The ABC system recognizes that a batch of both products consume the same quantity of purchasing, receiving and inspection activities and, for these activities, allocates the same costs to both products. Because product B is manufactured in batches of 200 units, and product A in batches of 100 units, the cost per unit of output for product B is half the amount of Product A for these activities. Product A also has five unique machined components, whereas product B has only one, resulting in a batch of Product A requiring five production runs whereas a batch of Product B only requires one. Therefore, relative to product B, the ABC system assigns five times more costs to product A for the production scheduling and disbursement of materials activities (see columns 5 and 6 in the lower part of Exhibit 13.1). Because product A is a more complex product it requires relatively more support activity resources and the cost of this complexity is captured by the ABC system.

The unit costs derived from traditional and ABC systems must be used with care. For example, if a customer requested a batch of 400 units of product B the cost would not be twice the amount of a batch of 200 units. Assuming that for a batch of 400 units the number of purchase orders, material receipts, production runs, set-up hours and inspections remained the same as that required for a batch of 200 units the cost of the support activities would remain unchanged, but the direct costs would increase by a factor of two to reflect the fact that twice the amount of resources would be required.

Designing ABC systems

The discussion so far has provided a broad overview of ABC. We shall now examine ABC in more detail by looking at the design of ABC systems. Four steps are involved. They are:

1. identifying the major activities that take place in an organization;
2. assigning costs to cost pools/cost centres for each activity;
3. determining the cost driver for each major activity;
4. assigning the cost of activities to products according to the product's demand for activities.

The first two steps relate to the first stage, and the final two steps to the second stage, of the two-stage allocation process shown in Figure 13.1. Let us now consider each of these stages in more detail.

Step 1: Identifying activities

Activities are composed of the aggregation of units of work or tasks and are described by verbs associated with tasks. For example, purchasing of materials might be identified as a separate activity. This activity consists of the aggregation of many different tasks, such as receiving a purchase request, identifying suppliers, preparing purchase orders, mailing purchase orders and performing follow-ups.

Activities are identified by carrying out an activity analysis. Innes and Mitchell (1995b) suggest that a useful starting point is to examine a physical plan of the work-place (to identify how all work space is being used) and the payroll listings (to ensure all relevant personnel have been taken into account). This examination normally has to be supplemented by a series of interviews with the staff involved, or having staff complete a time sheet for a specific time period explaining how their time is spent. Interviewers will ask managers and employees questions such as what staff work at the location and what tasks are performed by the persons employed at the location.

Many detailed tasks are likely to be identified in the first instance, but after further interviews, the main activities will emerge. The activities chosen should be at a reasonable level of aggregation based on costs versus benefits criteria. For example, rather than classifying purchasing of materials as an activity, each of its constituent tasks could be classified as separate activities. However, this level of decomposition would involve the collection of a vast amount of data and is likely to be too costly for product costing purposes. Alternatively, the purchasing activity might be merged with the materials receiving, storage and issuing activities to form a single materials procurement and handling activity. This is likely to represent too

high a level of aggregation because a single cost driver is unlikely to provide a satisfactory determinant of the cost of the activity. For example, selecting the number of purchase orders as a cost driver may provide a good explanation of purchasing costs but may be entirely inappropriate for explaining costs relating to receiving and issuing. Therefore, instead of establishing materials procurement and handling as a single activity it may be preferable to decompose it into three separate activities; namely purchasing, receiving and issuing activities, and establish separate cost drivers for each activity.

In some of the early ABC systems hundreds of separate activity cost centres were established but recent studies suggest that between twenty and thirty activity centres tend to be the norm. The final choice of activities must be a matter of judgement but it is likely to be influenced by factors such as the total cost of the activity centre (it must be of significance to justify separate treatment) and the ability of a single driver to provide a satisfactory determinant of the cost of the activity.

Step 2: Assigning costs to activity cost centres

After the activities have been identified the cost of resources consumed over a specified period must be assigned to each activity. The aim is to determine how much the organization is spending on each of its activities. Many of the resources will be directly attributable to specific activity centres but others (such as labour and lighting and heating costs) may be indirect and jointly shared by several activities. These costs should be assigned to activities on the basis of cause-and-effect cost drivers, or interviews with staff who can provide reasonable estimates of the resources consumed by different activities. Arbitrary allocations should not be used. The greater the amount of costs traced to activity centres by cost apportionments at this stage the more arbitrary and less reliable will be the product cost information generated by ABC systems. Cause-and-effect cost drivers used at this stage to allocate shared resources to individual activities are called **resource cost drivers**.

Step 3: Selecting appropriate cost drivers for assigning the cost of activities to cost objects

In order to assign the costs attached to each activity cost centre to products a cost driver must be selected for each activity centre. Cost drivers used at this stage are called **activity cost drivers**. Several factors must be borne in mind when selecting a suitable cost driver. First, it should provide a good explanation of costs in each activity cost pool. Second, a cost driver should be easily measurable, the data should be relatively easy to obtain and be identifiable with products. The costs of measurement should therefore be taken into account.

Activity cost drivers consist of transaction and duration drivers. **Transaction drivers**, such as the number of purchase orders processed, number of customer orders processed, number of inspections performed and the number of set-ups undertaken, all count the number of times an activity is performed. Transaction drivers are the least expensive type of cost driver but they are also likely to be the least accurate because they assume that the same quantity of resources is required every time an activity is performed. However, if the variation in the amount of resources required by individual cost objects is not great transaction drivers will

provide a reasonably accurate measurement of activity resources consumed. If this condition does not apply then duration cost drivers should be used.

Duration drivers represent the amount of time required to perform an activity. Examples of duration drivers include set-up hours and inspection hours. For example, if one product requires a short set-up time and another requires a long time then using set-up hours as the cost driver will more accurately measure activity resource consumption than the transaction driver (number of set-ups) which assumes that an equal amount of activity resources are consumed by both products. Using the number of set-ups will result in the product that requires a long set-up time being undercosted whereas the product that requires a short set-up will be overcosted. This problem can be overcome by using set-up hours as the cost driver, but this will increase the measurement costs.

In most situations data will not initially be available relating to the past costs of activities or potential cost driver volumes. To ascertain potential cost drivers interviews will be required with the personnel involved with the specific activities. The interviews will seek to ascertain what causes the particular activity to consume resources and incur costs. The final choice of a cost driver is likely to be based on managerial judgement after taking into account the factors outlined above.

Step 4: Assigning the cost of the activities to products

The final stage involves applying the cost driver rates to products. Therefore the cost driver must be measurable in a way that enables it to be identified with individual products. Thus, if set-up hours are selected as a cost driver, there must be a mechanism for measuring the set-up hours consumed by each product. Alternatively, if the number of set-ups is selected as the cost driver measurements by products are not required since all products that require a set-up are charged with a constant set-up cost. The ease and cost of obtaining data on cost driver consumption by products is therefore a factor that must be considered during the third stage when an appropriate cost driver is being selected.

Activity hierarchies

ABC systems classify manufacturing activities along a cost hierarchy dimension consisting of:

1. unit-level activities;
2. batch-level activities;
3. product-sustaining activities;
4. facility-sustaining activities.

Unit-level activities (also known as volume-related activities) are performed each time a unit of the product or service is produced. Expenses in this category include direct labour, direct materials, energy costs and expenses that are consumed in proportion to machine processing time (such as maintenance). Unit-level activities consume resources in proportion to the number of units of production and sales volume. For example, if a firm produces 10% more units it will consume 10% more labour cost, 10% more machine hours and 10% more energy costs. Typical cost drivers

for unit level activities include labour hours, machine hours and the quantity of materials processed. These cost drivers are also used by traditional costing systems. Traditional systems are therefore also appropriate for assigning the costs of unit-level activities to cost objects.

Batch-related activities, such as setting up a machine or processing a purchase order, are performed each time a batch of goods is produced. The cost of batch-related activities varies with the number of batches made, but is common (or fixed) for all units within the batch. For example, set-up resources are consumed when a machine is changed from one product to another. As more batches are produced, more set-up resources are consumed. It costs the same to set-up a machine for 10 or 5000 items. Thus the demands for the set-up resources are independent of the number of units produced after completing the set-up. Similarly, purchasing resources are consumed each time a purchasing order is processed, but the resources consumed are independent of the number of units included in the purchase order. Other examples of batch-related costs include resources devoted to production scheduling, first-item inspection and materials movement. Traditional costing systems treat batch-related expenses as fixed costs, whereas ABC systems assume that they vary with the number of batches produced.

Product-sustaining activities or **service-sustaining activities** are performed to enable the production and sale of individual products (or services). Examples of product-sustaining activities provided by Kaplan and Cooper (1998) include maintaining and updating product specifications and the technical support provided for individual products and services. Other examples are the resources to prepare and implement engineering change notices (ECNs), to design processes and test routines for individual products, and to perform product enhancements. The costs of product-sustaining activities are incurred irrespective of the number of units of output or the number of batches processed and their expenses will tend to increase as the number of products manufactured is increased. ABC uses product-level bases such as number of active part numbers and number of ECNs to assign these costs to products.

The final activity category is **facility-sustaining** (or **business-sustaining**) **activities**. They are performed to support the facility's general manufacturing process and include general administrative staff, plant management and property costs. They are incurred to support the organization as a whole and are common and joint to all products manufactured in the plant. There would have to be a dramatic change in activity, resulting in an expansion or contraction in the size of the plant, for facility-sustaining costs to change. Such events are most unlikely in most organizations. Therefore the ABC literature advocates that these costs should not be assigned to products since they are unavoidable and irrelevant for most decisions. Instead, they are regarded as common costs to *all* products made in the plant and deducted as a lump sum from the total of the operating margins from *all* products.

Cost versus benefits considerations

In Chapter 4 it was pointed out that the design of a cost system should be based on cost versus benefit considerations. A sophisticated ABC system should generate the most accurate product costs. However, the cost of implementing and operating an ABC system is significantly more expensive than operating a direct costing or a traditional costing system. The partial costs reported by direct costing systems, and the distorted costs reported by traditional systems, may result in significant mistakes

in decisions (such as selling unprofitable products or dropping profitable products) arising from the use of this information. If the cost of errors arising from using partial or distorted information generated from using these systems exceeds the additional costs of implementing and operating an ABC system then an ABC system ought to be implemented. In other words ABC must meet the cost–benefit criterion and improvements should be made in the level of sophistication of the costing system up to the point where the marginal cost of improvement equals the marginal benefit from improvement.

The optimal costing system is different for different organizations. A simplistic traditional costing system may report reasonably accurate product costs in organizations that have the following characteristics:

1. low levels of competition;
2. non-volume-related indirect costs that are a low proportion of total indirect costs;
3. a fairly standardized product range all consuming organizational resources in similar proportions (i.e. low product diversity).

In contrast, a sophisticated ABC system may be optimal for organizations having following characteristics:

1. intensive competition;
2. non-volume-related indirect costs that are a high proportion of total indirect costs;
3. a diverse range of products, all consuming organizational resources in significantly different proportions (i.e. high product diversity).

Periodic review of an ABC database

The detailed tracking of costs is unnecessary when ABC information is used for decision-making. A database should be maintained that is reviewed periodically, say once or twice a year. In addition periodic cost and profitability audits should be undertaken to provide a strategic review of the costs and profitability of a firm's products, customers and sales outlets. The database and periodic cost and profitability review can be based on either past or future costs. Early adopters, and firms starting off with ABC initially analysed past costs. However, rather than focusing on the past it is preferable to concentrate on the future profitability of products and customers using estimated activity-based costs. It is therefore recommended that an activity-cost database is maintained at estimated standard costs that are updated on an annual or semi-annual basis.

ABC in service organizations

Kaplan and Cooper (1998) suggest that service companies are ideal candidates for ABC, even more than manufacturing companies. Their justification for this statement is that most of the costs in service organizations are indirect. In contrast, manufacturing companies can trace important components (such as direct materials and direct labour) of costs to individual products. Therefore indirect costs are likely to be a much smaller proportion of total costs. Service organizations must also supply most of their resources in advance and fluctuations in the usage of activity resources by individual



services and customers does not influence short-term spending to supply the resources. Such costs are treated by traditional costing systems as fixed and irrelevant for most decisions. This resulted in a situation where profitability analysis was not considered helpful for decision-making. Furthermore, until recently many service organizations were either government-owned monopolies or operated in a highly regulated, protected and non-competitive environment. These organizations were not subject to any great pressures to improve profitability by identifying and eliminating non-profit-making activities. Cost increases could also be absorbed by increasing the prices of services to customers. Little attention was therefore given to developing cost systems that accurately measured the costs and profitability of individual services.

Privatization of government-owned monopolies, deregulation, intensive competition and an expanding product range created the need for service organizations to develop management accounting systems that enabled them to understand their cost base and determine the sources of profitability for their products/services, customers and markets.

A UK survey by Drury and Tayles (2000) suggests that service organizations are more likely to implement ABC systems. They reported that 51% of the financial and service organizations surveyed, compared with 15% of manufacturing organizations, had implemented ABC. Kaplan and Cooper (1998) illustrate how ABC was applied in The Co-operative Bank, a medium-sized UK bank. ABC was used for product and customer profitability analysis. The following are some of the activities and cost drivers that were identified:

Activity	Cost driver
Provide ATM services	Number of ATM transactions
Clear debit items	Number of debits processed
Clear credit items	Number of credits processed
Issue chequebooks	Number of chequebooks issued
Computer processing	Number of computer transactions
Prepare statements of account transactions	Number of statements issued
Administer mortgages	Number of mortgages maintained

Activity costs were allocated to the different savings and loans products based on their demand for the activities using the cost drivers as a measure of resource consumption. Some expenses, such as finance and human resource management, were not assigned to products because they were considered to be for the benefit of the organization as a whole and not attributable to individual products. These business sustaining costs represented approximately 15% of total operating expenses. Profitability analysis was extended to customer segments within product groups. The study revealed that approximately half of the current accounts, particularly those with low balances and high transactions, were unprofitable. By identifying the profitable customer segments the marketing function was able to direct its effort to attracting more new customers, and enhancing relationships with those existing customers, whose behaviour would be profitable to the bank.



ABC within a service organization

On face value, product costing at British Telecom (BT) should be both simple and uncontroversial. This is not so for two reasons:

- Most products share the use of the same network or support structure and costs do not vary with volume usage. This means that relatively few costs can be directly allocated to individual products and even apportionment poses practical problems.
- Different product costs are subject to different levels of competition. There are few natural markets in which prices can be established; therefore prices tend to be cost-based and subject to the approval of the regulator. BT's cost allocation processes must be open to detailed scrutiny to prove there is no unfair cross-subsidization between competitive and monopoly activities.

The fundamental principle underlying BT's methods, cost causation, states that costs should be apportioned on the basis of what caused them to be incurred. BT's cost apportionments use a variety of non-financial data taken from all parts of the business. For marketing and sales costs, traditional techniques would probably treat these costs as fixed or allocate them based on turnover. The BT approach is to analyse by activity and to seek a cost driver for each. In other words, ABC techniques are used to allocate costs to products via activity analysis.

There has been an increasing drive from the government to break up monopolies and introduce further privatization. This is likely to leave a general network provider who will provide a fixed-cost asset base used jointly by other parties. Problems of how to charge equitably for this usage are likely to result in an even greater pressure for accurate fixed cost analysis. One answer may be a more extended use of ABC techniques in the way that BT has adopted them.

Source: Bussey, B.A. (1993), ABC within a service organization, *Management Accounting* (UK), pp. 40–1, 65.

ABC cost management applications

Our aim in this chapter has been to look at how ABC can be used to provide information for decision-making by more accurately assigning costs to cost objects, such as products, customers and locations. In addition, ABC can be used for a range of cost management applications. They include cost reduction, activity-based budgeting, performance measurement, benchmarking of activities, process management and business process re-engineering. Figure 13.2 illustrates the product costing and cost management applications of ABC. The vertical box relates to product costing where costs are first assigned to activities and then to cost objects. The horizontal box relates to cost management. Here a process approach is adopted and costs are assigned to activities which then represent the basis for cost management applications. Thus, ABC can be adopted for both product costing and cost management or applied only to product costing or cost management. If ABC is only applied to cost management the second stage of assigning costs from activities to cost objects is omitted.

FIGURE 13.2 *Product costing and cost management applications of ABC*

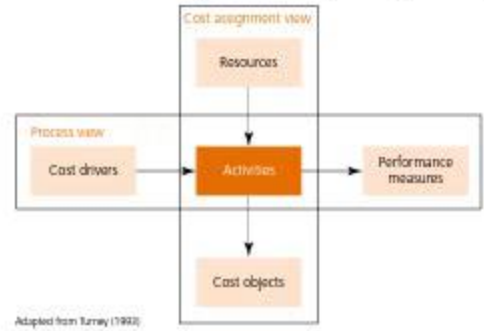


EXHIBIT 13.2
Surveys of company practice

Significant variations in the usage of ABC both within the same country and across different countries have been reported. These differences may arise from the difficulty in precisely defining the difference between traditional costing systems and ABC systems and the specific time period when the surveys were actually undertaken.

Survey evidence suggests that over the last decade there has been an increasing interest in ABC. In the UK, surveys in the early 1990s reported adoption rates around 10% (Innes and Mitchell, 1991; Nicholls, 1992; Drury *et al.*, 1993). Similar adoption rates of 10% were found in Ireland (Clarke, 1992) and 14% in Canada (Armitage and Nicholson, 1993). In the USA Green and Amenkhienan (1992) claimed that 45% of firms used ABC to some extent. More recent surveys suggest higher ABC adoption rates. In the UK reported usage was 18% (Innes *et al.*, 2000), 22% (Banerjee and Kane, 1996), 21% (Evans and Ashworth, 1996) and 23% (Drury and Tayles, 2000). In the USA Shim and Stagliano (1997) reported a usage rate of 27%.

Reported usage rates for mainland Europe are 19% in Belgium (Bruggeman *et al.*, 1996) and 6% in Finland in 1992, 11% in 1993 and 24% in 1995 (Virtanen *et al.*, 1996). Low usage rates have been reported in Denmark (Israelsen *et al.*, 1996), Sweden (Ask *et al.*, 1996) and Germany (Scherrer, 1996). Activity-based techniques do not appear to have been adopted in Greece (Ballas and Venieris, 1996), Italy (Barbato *et al.*, 1996) or Spain (Saez-Torrecilla *et al.*, 1996).

Other studies have examined the applications of ABC. Innes and Mitchell (1995a) and Innes *et al.* (2000) found that cost reduction was the most widely used application. Other widely used applications included product/service pricing, cost modelling and performance measurement/improvement. ABC was used for stock valuation by 29% of ABC adopters thus suggesting that the majority of ABC users have separate systems for stock valuation and management accounting applications.

According to Bjornenak (1997a) there has been little research on who adopts ABC and for what reasons. His survey indicated that 40% of the responding Norwegian companies had adopted ABC as an idea (i.e. they had implemented ABC or planned to do so). Different variables relating to cost structure, competition, existing cost systems, size and product diversity were tested as explanatory factors for the adoption of ABC but only cost structure and size were found to be statistically significant. The UK study by Drury and Tayles indicated that company size and business sector had a significant impact on ABC adoption rates. The adoption rates were 45% for the largest organizations and 51% for financial and service organizations. Although the ABC adopters used significantly more cost pools and cost drivers than the non-adopters most adopters used fewer cost pools and drivers compared with what is recommended in the literature. Approximately, 50% of the ABC adopters used less than 50 cost centres and less than 10 separate types of cost driver rates.

Friedman and Lyne (1995, 1999) used longitudinal case studies to study the factors influencing ABC success and failure in 12 UK companies. They observed that top management support was a significant factor influencing the success or failure of ABC systems. Implementation problems identified by the various studies included the amount of work in setting up the system and data collection, difficulties in identifying activities and selecting cost drivers, lack of resources and inadequate computer software. The benefits reported by the studies included more accurate cost information for product pricing, more accurate profitability analysis, improved cost control and a better understanding of cost causation.

Studies in the USA by Shields (1995) and McGowan and Klammer (1997) indicated that ABC success was linked to six behavioural and organizational variables. They were top management support; integration with competitive strategy initiatives (e.g. total quality management and just-in-time); performance evaluation and compensation; non-accounting ownership of the ABC project; training provided in designing, implementing and using ABC; and the provision of adequate resourcing. Technical characteristics of the systems had no influence.

The decision to implement ABC should not, therefore, be based only on its ability to produce more accurate and relevant decision-making information. Indeed, surveys by Innes and Mitchell (1995a) and Innes *et al.* (2000) on ABC applications suggests that the cost management applications tend to outweigh the product costing applications which were central to ABC's initial development. We shall examine ABC applications to cost management in Chapter 17.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain why a cost accumulation system is required for generating relevant cost information for decision-making.**

  Many indirect costs are relevant for decision-making and a costing system is therefore required that provides an estimate of resources consumed by cost objects using cause-and-effect allocations to allocate indirect costs.

- **Describe the differences between activity-based and traditional costing systems.**

  The major differences relate to the two-stage allocation process. In the first stage, traditional systems allocate indirect costs to cost centres (normally departments) whereas activity-based systems allocate indirect costs to cost centres based on activities rather than departments. Since there are many more activities than departments a distinguishing feature is that activity-based systems will have a greater number of cost centres in the first stage of the allocation process. In the second stage, traditional systems use a limited number of different types of second stage volume-based allocation bases (cost drivers) whereas activity-based systems use many different types of volume-based and non-volume-based cause-and-effect second stage drivers.

- **Explain why traditional costing systems can provide misleading information for decision-making.**

  Traditional systems often tend to rely on arbitrary allocations of indirect costs. In particular, they rely extensively on volume-based allocations. Many indirect costs are not volume-based but, if volume-based allocation bases are used, high-volume products are likely to be assigned with a greater proportion of indirect costs than they have consumed whereas low-volume products will be assigned a lower proportion. In these circumstances traditional systems will overcost high-volume products and undercost low-volume products. In contrast, ABC systems recognize that many indirect costs vary in proportion to changes other than production volume. By identifying the cost drivers that cause the costs to change and assigning costs to cost objects on the basis of cost driver usage, costs can be more accurately traced. It is claimed that this cause-and-effect relationship provides a superior way of determining relevant costs.

- **Compute product costs using an ABC system.**

  Cost driver (overhead allocation rates) are established for each activity cost pool and assigned to cost objects using the two-stage allocation overhead procedure. In the first stage an overhead analysis sheet is used to allocate overheads to activity cost pools using resource cost drivers. The second stage involves (a) the calculation of appropriate activity cost driver rates and (b) the assignment of overheads to products passing through each activity cost centre based on cost driver usage. These steps were illustrated using data presented in Example 4.1.

- **Identify and explain each of the four stages involved in designing ABC systems.**

  The design of ABC systems involves the following four stages: (a) identify the major activities that take place in the organization; (b) create a cost centre/cost pool for each activity; (c) determine the cost driver for each major activity; and (d) trace the cost of activities to the product according to a product's demand (using cost drivers as a measure of demand) for activities.

- **Describe the ABC cost hierarchy.**

  ABC systems classify activities along a cost hierarchy consisting of unit-level, batch-level, product-sustaining and facility-sustaining activities. Unit-level activities are performed each time a unit of the product or service is produced. Examples include direct labour and energy costs. Batch-level activities are performed each time a batch is produced. Examples include setting up a machine or processing a purchase order. Product-sustaining activities are performed to enable the production and sale of individual products. Examples include the technical support provided for individual products and the resources required performing product enhancements. Facility-sustaining activities are performed to support the facility's general manufacturing process. They include general administrative staff and property support costs.



Key terms and concepts

activities (p. 349)
activity cost driver (p. 361)
batch-related activities (p. 363)
business-sustaining activities (p. 363)
consumption ratios (p. 353)
cost driver (p. 349)
duration driver (p. 362)
facility-sustaining activities (p. 363)
non-volume based cost driver (p. 352)
product-sustaining activities (p. 363)
resource cost driver (p. 361)
service-sustaining activities (p. 363)
transaction driver (p. 361)
unit-level activities (p. 362)
volume-based cost driver (p. 351)

Key examination points

ABC did not emerge until the late 1980s, and therefore fewer questions have been set on this topic. As a result a smaller number of questions are included in this chapter. It is likely that most questions will require you to compute product costs for a traditional system and an activity-based system and explain the difference between the product costs. It is also likely that examiners will require you to outline the circumstances where ABC systems are likely to prove most beneficial.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

13.1 Explain why a cost accumulation system is required for generating relevant cost information for decision-making. (*p.348*)

13.2 Describe the three different types of cost systems that can be used to assign costs to cost objects. (*pp. 348–9*)

13.3 What are the fundamental differences between a traditional and an ABC system? (*pp. 349–50*)

13.4 Define activities and cost drivers. (*p. 349*)

13.5 What factors led to the emergence of ABC systems? (*pp. 350–1*)

13.6 Distinguish between volume-based and non-volume-based cost drivers. (*pp. 351–2*)

13.7 Describe the circumstances when traditional costing systems are likely to report distorted costs. (*p. 352, pp. 363–4*)

13.8 Explain how low volume products can be undercosted and high volume products overcosted when traditional costing systems are used. (*pp. 352–3*)

13.9 What is meant by 'product diversity' and why is it important for product costing? (*p. 352*)

13.10 Describe each of the four stages involved in designing ABC systems. (*pp. 360–2*)

13.11 Distinguish between resource cost drivers and activity cost drivers. (*p. 361*)

13.12 Distinguish between transaction and duration cost drivers. (*pp. 361–2*)

13.13 Describe the ABC manufacturing cost hierarchy. (*pp. 362–3*)

13.14 Explain the circumstances when ABC is likely to be preferred to traditional costing systems. (*p. 364*)

13.15 Provide examples of how ABC can be used in service organizations. (*pp. 364–5*)

Review problems

13.16 S Ltd manufactures components for the aircraft industry. The following annual information regarding three of its key customers is available:

	W	X	Y
Gross margin	£1 100 000	£1 750 000	£1 200 000
General administration costs	£40 000	£80 000	£30 000
Units sold	1 750	2 000	1 500
Orders placed	1 000	1 000	1 500
Sales visits	110	100	170
Invoices raised	900	1 200	1 500

The company uses an activity-based costing system and the analysis of customer-related costs is as follows:

Sales visits	£500 per visit
Order processing	£100 per order placed
Despatch costs	£100 per order placed
Billing and collections	£175 per invoice raised

Using customer profitability analysis, the ranking of the customers would be:

	W	X	Y
A	1st	2nd	3rd
B	1st	3rd	2nd
C	2nd	1st	3rd
D	2nd	3rd	1st
E	3rd	2nd	1st

(4 marks)

CIMA Management Accounting – Decision Making

13.17 DRP Limited has recently introduced an activity-based costing system. It manufactures three products, details of which are set out below:

	Product D	Product R	Product P
Budgeted annual production (units)	100 000	100 000	50 000
Batch size (units)	100	50	25
Machine set-ups per batch	3	4	6
Purchase orders per batch	2	1	1
Processing time per unit (minutes)	2	3	3

Three cost pools have been identified. Their budgeted costs for the year ending 30 June 2003 are as follows:

Machine set-up costs	£150 000
Purchasing of materials	£70 000
Processing	£80 000

The budgeted machine set-up cost per unit of product R is nearest to

A £0.52 B £0.60 C £6.52 D £26.09

(3 marks)

CIMA Management Accounting – Performance Management

13.18 (a) Explain the following terms giving an example of each:

(i) service centre; and
(ii) production centre.

Explain how the treatment of overheads differs between the two different types of centre.

(6 marks)

(b) Explain how activity-based costing differs from traditional absorption costing, giving an example.

(4 marks)

ACCA – Financial Information for Management

13.19 *It is now fairly widely accepted that conventional cost accounting distorts management's view of business through unrepresentative overhead allocation and inappropriate product costing.*

This is because the traditional approach usually absorbs overhead costs across products and orders solely on the basis of the direct labour involved in their manufacture. And as direct labour as a proportion of total manufacturing cost continues to fall, this leads to more and more distortion and misrepresentation of the impact of particular products on total overhead costs.

(From an article in *The Financial Times*)

You are required to discuss the above and to suggest what approaches are being adopted by management accountants to overcome such criticism.

(15 marks)

CIMA Stage 2 Cost Accounting

13.20 Comparison of traditional product costing with ABC

Having attended a CIMA course on activity-based costing (ABC) you decide to experiment by applying the principles of ABC to the four products currently made and sold by your company. Details of the four products and relevant information are given below for one period:

Product	A	B	C	D
Output in units	120	100	80	120
Costs per unit:	(£)	(£)	(£)	(£)
Direct material	40	50	30	60
Direct labour	28	21	14	21
Machine hours (per unit)	4	3	2	3

The four products are similar and are usually produced in production runs of 20 units and sold in batches of 10 units.

The production overhead is currently absorbed by using a machine hour rate, and the total of the production overhead for the period has been analysed as follows:

	(£)
Machine department costs (rent, business rates, depreciation and supervision)	10 430
Set-up costs	5 250
Stores receiving	3 600
Inspection/Quality control	2 100
Materials handling and despatch	4 620

You have ascertained that the 'cost drivers' to be used are as listed below for the overhead costs shown:

Cost	Cost Driver
Set-up costs	Number of production runs
Stores receiving	Requisitions raised
Inspection/Quality control	Number of production runs
Materials handling and despatch	Orders executed

The number of requisitions raised on the stores was 20 for each product and the number of orders executed was 42, each order being for a batch of 10 of a product. You are required

(a) to calculate the total costs for each product if all overhead costs are absorbed on a machine hour basis;

(4 marks)

(b) to calculate the total costs for each product, using activity-based costing;

(7 marks)

(c) to calculate and list the unit product costs from your figures in (a) and (b) above, to show the differences and to comment briefly on any conclusions which may be drawn which could have pricing and profit implications.

(4 marks)

(Total 15 marks)

CIMA Stage 2 Cost Accounting



Decision-making under conditions of risk and uncertainty

14

In Chapters 9–13 we considered the use of a single representative set of estimates for predicting future costs and revenues for alternative courses of action. However, the outcome of a particular decision may be affected by an uncertain environment that cannot be predicted, and a single representative estimate does not therefore convey all the information that might reasonably influence a decision.

Consider a situation where a company has two mutually exclusive potential alternatives, A and B, which each yield receipts of £50 000. The estimated costs of alternative A can be predicted with considerable confidence, and are expected to fall in the range of £40 000–£42 000; £41 000 might be considered a reasonable estimate of cost. The estimate for alternative B is subject to much greater uncertainty, since this alternative requires high-precision work involving operations that are unfamiliar to the company's labour force. The estimated costs are between £35 000 and £45 000, but £40 000 is selected as a representative estimate. If we consider single representative estimates alternative B appears preferable, since the estimated profit is £10 000 compared with an estimated profit of £9000 for alternative A; but a different picture may emerge if we take into account the range of possible outcomes.

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- calculate and explain the meaning of expected values;
- explain the meaning of the terms standard deviation and coefficient of variation as measures of risk and outline their limitations;
- construct a decision tree when there is a range of alternatives and possible outcomes;
- describe and calculate the value of perfect and imperfect information.

Alternative A is expected to yield a profit of between £8000 and £10 000 whereas the range of profits for alternative B is between £5000 and £15 000. Management may consider it preferable to opt for a fairly certain profit of between £8000 and £10 000 for alternative A rather than take the chance of earning a profit of £5000 from alternative B (even though there is the possibility of earning a profit of £15 000 at the other extreme).

This example demonstrates that there is a need to incorporate the uncertainty relating to each alternative into the decision-making process, and in this chapter we shall consider some of the methods of doing this. Decision-making under conditions of uncertainty is a topic that is often included in second-level management accounting courses but recently some professional accounting examining bodies have incorporated this topic in first-level courses. You should therefore check your course content to ascertain if you need to read this chapter.

Probabilities



Because decision problems exist in an uncertain environment, it is necessary to consider those uncontrollable factors that are outside the decision-maker's control and that may occur for alternative courses of action. These uncontrollable factors are called **events** or **states of nature**. For example, in a product launch situation possible states of nature could consist of events such as a similar product being launched by a competitor at a lower price, at the same price, at a higher price or no similar product being launched.

The likelihood that an event or state of nature will occur is known as its **probability**, and this is normally expressed in decimal form with a value between 0 and 1. A value of 0 denotes a nil likelihood of occurrence whereas a value of 1 signifies absolute certainty – a definite occurrence. A probability of 0.4 means that the event is expected to occur four times out of ten. The total of the probabilities for events that can possibly occur must sum to 1.0. For example, if a tutor indicates that the probability of a student passing an examination is 0.7 then this means that the student has a 70% chance of passing the examination. Given that the pass/fail alternatives represent an exhaustive listing of all possible outcomes of the event, the probability of not passing the examination is 0.3.

The information can be presented in a **probability distribution**. A probability distribution is a list of all possible outcomes for an event and the probability that each will occur. The probability distribution for the above illustration is as follows:

Outcome	Probability
Pass examination	0.7
Do not pass examination	0.3
Total	1.0

Some probabilities are known as **objective probabilities** because they can be established mathematically or compiled from historical data. Tossing a coin and throwing a die are examples of objective probabilities. For example, the probability of heads occurring when tossing a coin logically must be 0.5. This can be proved by tossing the coin many times and observing the results. Similarly, the probability of obtaining number 1 when a die is thrown is 0.166 (i.e. one-sixth). This again can be

ascertained from logical reasoning or recording the results obtained from repeated throws of the dice.

It is unlikely that objective probabilities can be established for business decisions, since many past observations or repeated experiments for particular decisions are not possible; the probabilities will have to be estimated based on managerial judgement. Probabilities established in this way are known as **subjective probabilities** because no two individuals will necessarily assign the same probabilities to a particular outcome. Subjective probabilities are based on an individual's expert knowledge, past experience, and observations of current variables which are likely to have an impact on future events. Such probabilities are unlikely to be estimated correctly, but any estimate of a future uncertain event is bound to be subject to error.

The advantage of this approach is that it provides more meaningful information than stating the most likely outcome. Consider, for example, a situation where a tutor is asked to state whether student A and student B will pass an examination. The tutor may reply that both students are expected to pass the examination. This is the tutor's estimate of the most likely outcome. However, the following probability distributions are preferable:

Outcome	Student A probability	Student B probability
Pass examination	0.9	0.6
Do not pass examination	0.1	0.4
Total	1.0	1.0

Such a probability distribution requires the tutor to specify the degree of confidence in his or her estimate of the likely outcome of a future event. This information is clearly more meaningful than a mere estimate of the most likely outcome that both students are expected to pass the examination, because it indicates that it is most unlikely that A will fail, whereas there is a possibility that B will fail. Let us now apply the principles of probability theory to business decision-making.

Probability distributions and expected value

The presentation of a probability distribution for each alternative course of action can provide useful additional information to management, since the distribution indicates the degree of uncertainty that exists for each alternative course of action. Probability distributions enable management to consider not only the possible profits (i.e. the pay-off) from each alternative course of action but also the amount of uncertainty that applies to each alternative. Let us now consider the situation presented in Example 14.1.

From the probability distributions shown in Example 14.1 you will see that there is a 1 in 10 chance that profits will be £6000 for product A, but there is also a 4 in 10 chance that profits will be £8000. A more useful way of reading the probability distribution is to state that there is a 7 in 10 chance that profits will be £8000 or less. This is obtained by adding together the probabilities for profits of £6000, £7000 and £8000. Similarly, there is a 3 in 10 chance that profits will be £9000 or more.

EXAMPLE 14.1

A manager is considering whether to make product A or product B, but only one can be produced. The estimated sales demand for each product is uncertain. A detailed investigation of the possible sales demand for each product gives the following probability distribution of the profits for each product.

Product A probability distribution

(1) Outcome	(2) Estimated probability	(3) Weighted (col. 1 amount × col. 2) (£)
Profits of £6000	0.10	600
Profits of £7000	0.20	1400
Profits of £8000	0.40	3200
Profits of £9000	0.20	1800
Profits of £10 000	0.10	1000
	1.00	
	Expected value	8000

Product B probability distribution

(1) Outcome	(2) Estimated probability	(3) Weighted (col. 1 amount × col. 2) (£)
Profits of £4000	0.05	200
Profits of £6000	0.10	600
Profits of £8000	0.40	3200
Profits of £10 000	0.25	2500
Profits of £12 000	0.20	2400
	1.00	
	Expected value	8900

Which product should the company make?

Expected values

The **expected value** (sometimes called expected pay-off) is calculated by weighting each of the profit levels (i.e. possible outcomes) in Example 14.1 by its associated probability. The sum of these weighted amounts is called the expected value of the probability distribution. In other words, the expected value is the weighted arithmetic mean of the possible outcomes. The expected values of £8000 and £8900 calculated for products A and B take into account a range of possible outcomes rather than using a **single most likely estimate**. For example, the single most likely estimate is the profit level with the highest probability attached to it. For both

products A and B in Example 14.1 the single most likely estimate is £8000, which appears to indicate that we may be indifferent as to which product should be made. However the expected value calculation takes into account the possibility that a range of different profits are possible and weights these profits by the probability of their occurrence. The weighted calculation indicates that product B is expected to produce the highest average profits in the future.

The expected value of a decision represents the long-run average outcome that is expected to occur if a particular course of action is undertaken many times. For example, if the decision to make products A and B is repeated on, say, 100 occasions in the future then product A will be expected to give an average profit of £8000 whereas product B would be expected to give an average profit of £8900. The expected values are the averages of the possible outcomes based on management estimates. There is no guarantee that the actual outcome will equal the expected value. Indeed, the expected value for product B does not appear in the probability distribution.

Measuring the amount of uncertainty

In addition to the expected values of the profits for the various alternatives, management is also interested in the degree of uncertainty of the expected future profits. For example, let us assume that another alternative course of action, say, product C, is added to the alternatives in Example 14.1 and that the probability distribution is as follows:

Product C probability distribution

Outcome	Estimated probability	Weighted amount (£)
Loss of £4000	0.5	(2000)
Profit of £22 000	0.5	11 000
	Expected value	9 000

Product C has a higher expected value than either product A or product B, but it is unlikely that management will prefer product C to product B, because of the greater variability of the possible outcomes. In other words, there is a greater degree of uncertainty attached to product C.

The conventional measure of the dispersion of a probability distribution is the **standard deviation**. The standard deviation (σ) is the square root of the mean of the squared deviations from the expected value and is calculated from the following formula:

$$\sigma = \sqrt{\sum_{i=1}^{n} (A_i - \bar{A})^2 P_i} \qquad (14.1)$$

where A_i are the profit-level observations, $\bar{A}$ is the expected or mean value, P_i is the probability of each outcome, and the summation is over all possible observations, where n is the total number of possibilities.

The calculations of the standard deviations for products A and B in Example 14.1 are set out in Exhibit 14.1. If we are comparing the standard deviations of two probability distributions with different expected values, we cannot make a direct comparison. Can you see why this should be so? Consider the following probability distribution for another product, say product D.

Product D probability distribution

Outcome	Estimated probability	Weighted amount (£)
Profits of £40 000	0.05	2 000
Profits of £60 000	0.10	6 000
Profits of £80 000	0.40	32 000
Profits of £100 000	0.25	25 000
Profits of £120 000	0.20	24 000
	Expected value	89 000

The standard deviation for product D is £21 424, but all of the possible outcomes are ten times as large as the corresponding outcomes for product B. The outcomes for product D also have the same pattern of probabilities as product B, and we might conclude that the two projects are equally risky. Nevertheless, the standard deviation for product D is ten times as large as that for product B. This scale effect can be removed by replacing the standard deviation with a relative measure of dispersion. The relative amount of dispersion can be expressed by the **coefficient of variation**, which is simply the standard deviation divided by the expected value. The coefficient of variation for product B is 2142.40/8900 = 0.241 (or 24.1%), and for product D it is also 0.241 (21 424/89 000), thus indicating that the relative amount of dispersion is the same for both products.

Measures such as expected values, standard deviations or coefficient of variations are used to summarize the characteristics of alternative courses of action, but they are poor substitutes for representing the probability distributions, since they do not provide the decision-maker with all the relevant information. There is an argument for presenting the entire probability distribution directly to the decision-maker. Such an approach is appropriate when management must select one from a small number of alternatives, but in situations where many alternatives need to be considered the examination of many probability distributions is likely to be difficult and time-consuming. In such situations management may have no alternative but to compare the expected values and coefficients of variation.

Decision-tree analysis

In the examples earlier in this chapter we have assumed that profits were uncertain because of the uncertainty of sales demand. In practice, more than one variable may be uncertain (e.g. sales and costs), and also the value of some variables may be dependent on the values of other variables. Many outcomes may therefore be possible, and some outcomes may be dependent on previous outcomes. A useful analytical tool for clarifying the range of alternative courses of action and their possible outcomes is a **decision tree**.

EXHIBIT 14.1

Calculation of standard deviations

Product A

(1) Profit (£)	(2) Deviation from expected value, $A_i - \bar{A}$ (£)	(3) Squared deviation $(A_i - \bar{A})^2$ (£)	(4) Probability	(5) Weighted amount (col. 3 × col. 4) (£)
6 000	−2000	4 000 000	0.1	400 000
7 000	−1000	1 000 000	0.2	200 000
8 000	0	–	0.4	–
9 000	+1000	1 000 000	0.2	200 000
10 000	+2000	4 000 000	0.1	400 000
			Sum of squared deviations	1 200 000
			Standard deviation	£1095.40
			Expected value	£8000

Product B

(1) Profit (£)	(2) Deviation $A_i - \bar{A}$ (£)	(3) Squared deviation $(A_i - \bar{A})^2$ (£)	(4) Probability	(5) Weighted amount (col. 3 × col. 4) (£)
4 000	−4900	24 010 000	0.05	1 200 500
6 000	−2900	8 410 000	0.10	841 000
8 000	−900	810 000	0.40	324 000
10 000	1100	1 210 000	0.25	302 500
12 000	3100	9 610 000	0.20	1 922 000
			Sum of squared deviations	4 590 000
			Standard deviation	£2142.40
			Expected value	£8900

A decision tree is a diagram showing several possible courses of action and possible events (i.e. states of nature) and the potential outcomes for each course of action. Each alternative course of action or event is represented by a branch, which leads to subsidiary branches for further courses of action or possible events. Decision trees are designed to illustrate the full range of alternatives and events that can occur, under all envisaged conditions. The value of a decision tree is that its logical analysis of a problem enables a complete strategy to be drawn up to cover all eventualities before a firm becomes committed to a scheme. Let us now consider Example 14.2. This will be used to illustrate how decision trees can be applied to decision-making under conditions of uncertainty.

The decision tree for Example 14.2 is set out in Figure 14.1. The boxes indicate the point at which decisions have to be taken, and the branches emanating from it indicate the available alternative courses of action. The circles indicate the points at which there are environmental changes that affect the consequences of prior

EXAMPLE 14.2

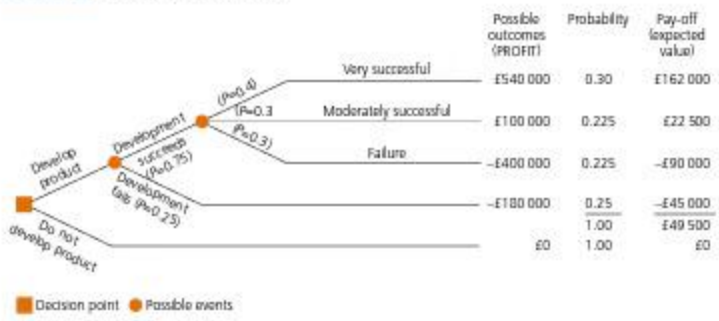
A company is considering whether to develop and market a new product. Development costs are estimated to be £180 000, and there is a 0.75 probability that the development effort will be successful and a 0.25 probability that the development effort will be unsuccessful. If the development is successful, the product will be marketed, and it is estimated that:

1. if the product is very successful profits will be £540 000;
2. if the product is moderately successful profits will be £100 000;
3. if the product is a failure, there will be a loss of £400 000.

Each of the above profit and loss calculations is after taking into account the development costs of £180 000. The estimated probabilities of each of the above events are as follows:

1	Very successful	0.4
2	Moderately successful	0.3
3	Failure	0.3

FIGURE 14.1 *A simple decision tree*



decisions. The branches from these points indicate the possible types of environment (states of nature) that may occur.

Note that the joint probability of two events occurring together is the probability of one event times the probability of the other event. For example, the probability of the development effort succeeding and the product being very successful consists of the products of the probabilities of these two events, i.e. 0.75 × 0.4, giving a probability of 0.30. Similarly, the probability of the development effort being successful and the product being moderately successful is 0.225 (0.75 × 0.3). The total expected value for the decision to develop the product consists of the sum of all the

items in the expected value column on the 'Develop product' branch of the decision tree, i.e. £49 500. If we assume that there are no other alternatives available, other than the decision not to develop, the expected value of £49 500 for developing the product can be compared with the expected value of zero for not developing the product. Decision theory would suggest that the product should be developed because a positive expected value occurs. However, this does not mean that an outcome of £49 500 profit is guaranteed. The expected-value calculation indicates that if the probabilities are correct and this decision was repeated on many occasions an average profit of £49 500 would result.

Unfortunately, the decision will not be repeated on many occasions, and a run of repeated losses could force a company out of business before it has the chance to repeat similar decisions. Management may therefore prefer to examine the following probability distribution for developing the product shown in Figure 14.1:

Outcome	Probability
Loss of £400 000	0.225
Loss of £180 000	0.25
Profit of £100 000	0.225
Profit of £540 000	0.30

Management may decide that the project is too risky, since there is nearly a 0.5 probability of a loss occurring.

The decision tree provides a convenient means of identifying all the possible alternative courses of action and their interdependencies. This approach is particularly useful for assisting in the construction of probability distributions when many combinations of events are possible.

Buying perfect and imperfect information

When a decision-maker is faced with a series of uncertain events that might occur, he or she should consider the possibility of obtaining additional information about which event is likely to occur. This section considers how we can calculate the maximum amount it would be worth paying to acquire additional information from a particular source. The approach we shall take is to compare the expected value of a decision if the information is acquired against the expected value with the absence of the information. The difference represents the maximum amount it is worth paying for the additional information. Consider Example 14.3.

Without the additional information, machine A will be purchased using the expected-value decision rule. If the additional information is obtained then this will give a perfect prediction of the level of demand, and the size of the machine can be matched with the level of demand. Therefore if demand is predicted to be low, machine A will be purchased, whereas if demand is predicted to be high, machine B will be purchased. The revised expected value is

$$(0.5 \times £100\,000) + (0.5 \times £200\,000) = £150\,000$$

You can see that the expected value is calculated by taking the highest profit in the case of low and high demand. When the decision to employ the market consultants

EXAMPLE 14.3

The Boston Company must choose between one of two machines – machine A has low fixed costs and high unit variable costs whereas machine B has high fixed costs and low unit variable costs. Consequently, machine A is most suited to low-level demand whereas machine B is suited to high-level demand. For simplicity assume that there are only two possible demand levels – low and high – and the estimated probability of each of these events is 0.5. The estimated profits for each demand level are as follows:

	Low demand (£)	High demand (£)	Expected value (£)
Machine A	100 000	160 000	130 000
Machine B	10 000	200 000	105 000

There is a possibility of employing a firm of market consultants who would be able to provide a perfect prediction of the actual demand. What is the maximum amount the company should be prepared to pay the consultants for the additional information?

is being taken, it is not known which level of demand will be predicted. Therefore the best estimate of the outcome from obtaining the additional information is a 0.5 probability that it will predict a low demand and a 0.5 probability that it will predict a high demand. (These are the probabilities that are currently associated with low and high demand.)

The value of the additional information is ascertained by deducting the expected value without the market survey (£130 000) from the expected value with the survey (£150 000). Thus the additional information increases expected value from £130 000 to £150 000 and the **expected value of perfect information** is £20 000. As long as the cost of obtaining the information is less than £20 000, the firm of market consultants should be employed.

In the above illustration it was assumed that the additional information would give a 100% accurate prediction of the expected demand. In practice, it is unlikely that *perfect* information is obtainable, but *imperfect* information (for example, predictions of future demand may be only 80% reliable) may still be worth obtaining. However, the value of imperfect information will always be less than the value of perfect information except when both equal zero. This would occur where the additional information would not change the decision. Note that the principles that are applied for calculating the value of imperfect information are the same as those we applied for calculating the value of perfect information, but the calculations are more complex. For an illustration see Scapens (1991).



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Calculate and explain the meaning of expected values.**

  The expected value is calculated by weighting each of the possible outcomes by its associated probability. The sum of these weighted outcomes is called the expected value of the probability distribution. In other words, the expected value is the weighted arithmetic mean of the possible outcomes.

- **Explain the meaning of the terms standard deviation and coefficient of variation as measures of risk and outline their limitations.**

  Standard deviation measures the dispersion of the possible outcomes. It is an absolute measure. In contrast, the coefficient of variation is a relative measure derived from dividing the standard deviation by the expected value. Both measures attempt to summarize the risk associated with a probability distribution. They assume that risk is measured in terms of the spread of possible outcomes. Decision-makers are probably more interested in a downside measure of risk that measures the possibility of risk being less than the expected value. Because of this there are strong arguments for presenting the entire probability distribution to the decision-maker.

- **Construct a decision tree when there is a range of alternatives and possible outcomes.**

  Where there are many possible outcomes for various alternatives, and some outcomes are dependent on previous outcomes, a decision tree is a useful analytical tool for clarifying the range of alternative courses of actions and their possible outcomes. A decision tree is a diagram that shows the possible courses of actions, the potential events (states of nature for each outcome) together with their potential outcomes and associated probabilities. A decision tree thus represents an analytical tool for deriving expected values and a probability distribution in more complex situations.

- **Describe and calculate the value of perfect and imperfect information.**

  The value of perfect and imperfect information relates to determining the value of the maximum amount it is worth paying for additional information. The approach involves comparing the expected value of a decision if the information is acquired against the expected value with the absence of the information. The difference represents the maximum value that it is worth paying for the additional information. You should refer to the section in the chapter on buying perfect and imperfect information for an illustration of the calculation of the value of perfect information.



Key terms and concepts

coefficient of variation (p. 380)
decision tree (p. 380)
events (p. 376)
expected value of perfect information (p. 384)
objective probabilities (p. 376)
probability (p. 376)
probability distribution (p. 376)
single most likely estimate (p. 378)
standard deviation (p. 379)
states of nature (p. 376)
subjective probabilities (p. 377)

Key examination points

When you are faced with problems requiring an evaluation of alternatives with uncertain outcomes, you should calculate expected values and present probability distributions.

Note that expected values on their own are unlikely to be particularly useful and there is a need to supplement this measure with a probability distribution. Avoid calculating standard deviations, since they are rarely required and are a poor substitute for probability distributions.

It is particularly important with this topic that you plan your answer carefully. Once you have started your answer, it is difficult to remedy the situation if you initially adopt the wrong approach. A rough sketch of a decision tree at the start of your answer will force you to analyse the problem and identify all the alternatives and possible outcomes.

Many examination questions on this topic also include a requirement as to whether additional perfect information should be purchased. Do make sure that you understand how to calculate the value of perfect information.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

14.1 What is a probability distribution? (*p. 376*)

14.2 How do subjective probabilities differ from objective probabilities? (*pp. 376–7*)

14.3 Distinguish between expected value and the single most likely estimate. (*p. 378*)

14.4 Distinguish between the standard deviation and the coefficient of variation. (*pp. 379–80*)

14.5 What is a decision tree and what purpose does it serve? (*pp. 380–3*)

14.6 What is the expected value of perfect information and how can it be determined? (*p. 384*)

Review problems

14.7 Which of the following are true with regard to expected values?

Expected values
(i) represents the single most likely estimate of an outcome.
(ii) take no account of decision-maker's risk.
(iii) are reliant on the accuracy of the probability distribution.

A (i), (ii) and (iii)
B (i) and (ii) only
C (i) and (iii) only
D (ii) and (iii) only.

ACCA Paper 1.2 – Financial information for Management

14.8 Darwin uses decision tree analysis in order to evaluate potential projects. The company has been looking at the launch of a new product which it believes has a 70% probability of success. The company is, however, considering undertaking an advertising campaign costing £50 000, which would increase the probability of success to 95%.

If successful the product would generate income of £200 000 otherwise £70 000 would be received.

What is the maximum that the company would be prepared to pay for the advertising?

A £32 500
B £29 000
C £17 500
D £50 000.

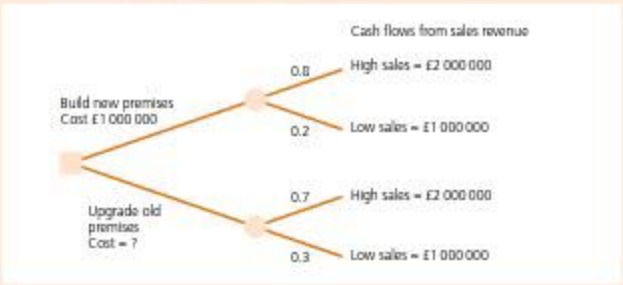
ACCA Paper 1.2 – Financial information for Management

14.9 Which of the following is correct with regard to expected values?

A Expected values provide a weighted average of anticipated outcomes
B The expected value will always equal one of the possible outcomes
C Expected values will show whether the decision-maker is risk averse, risk-seeking or risk neutral
D The expected value will never equal one of the possible outcomes

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14.10 A company uses decision tree analysis to evaluate potential options. The management accountant for the company has established the following:



What would be the cost of the upgrade that would make the company financially indifferent between building new premises and upgrading the old one?

A £100 000
B £900 000
C £1 000 000
D £1 700 000

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14.11 The following data relate to both questions (a) and (b)

X Ltd can choose from five mutually exclusive projects. The projects will each last for one year only and their net cash inflows will be determined by the prevailing market conditions. The forecast annual cash inflows and their associated probabilities are shown below:

Market conditions	Poor	Good	Excellent
Probability	0.20	0.50	0.30
	£000	£000	£000
Project L	500	470	550
Project M	400	550	570
Project N	450	400	475
Project O	360	400	420
Project P	600	500	425

(a) Based on the expected value of the net cash inflows, which project should be undertaken?

A L
B M
C N
D O
E P

(2 marks)

(b) The value of perfect information about the state of the market is

A Nil
B £5 000
C £26 000
D £40 000
E £128 000

(3 marks)
CIMA Management Accounting – Decision Making

14.12 Firlands Limited, a retail outlet, is faced with a decision regarding whether or not to expand and build small or large premises at a prime location. Small premises would cost £300 000 to build and large premises would cost £550 000.

Regardless of the type of premises built, if high demand exists then the net income is expected to be £1 500 000. Alternatively, if low demand exists, then net income is expected to be £600 000.

If large premises are built then the probability of high demand is 0.75. If the smaller premises are built then the probability of high demand falls to 0.6.

Firlands has the option of undertaking a survey costing £50 000. The survey predicts whether there is likely to be a good or bad response to the size of the premises. The likelihood of there being a good response, from previous surveys, has been estimated at 0.8.

If the survey indicates a good response then the company will build the large premises. If the survey does give a good result then the probability that there will be high demand from the large premises increases to 0.95.

If the survey indicates a bad response then the company will abandon all expansion plans.

Required:

Using decision tree analysis, establish the best course of action for Firlands Limited.

(10 marks)
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Capital investment decisions

15

Capital investment decisions are those decisions that involve current outlays in return for a stream of benefits in future years. It is true to say that all of the firm's expenditures are made in expectation of realizing future benefits. The distinguishing feature between short-term decisions and capital investment (long-term) decisions is time. Generally, we can classify short-term decisions as those that involve a relatively short time horizon, say less than one year, from the commitment of funds to the receipt of the benefits. On the other hand, capital investment decisions are those decisions where a significant period of time elapses between the outlay and the recoupment of the investment. We shall see that this commitment of funds for a significant period of time involves an interest cost, which must be brought into the analysis. With short-term decisions, funds are committed only for short periods of time, and the interest cost is normally so small that it can be ignored.

Capital investment decisions normally represent the most important decisions that an organization makes, since they commit a substantial proportion of a firm's resources to actions that are likely to be irreversible. Such decisions are applicable to all sectors of society. Business firms' investment decisions include investments in plant and

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- explain the opportunity cost of an investment;
- distinguish between compounding and discounting;
- explain the concepts of net present value (NPV), internal rate of return (IRR), payback method and accounting rate of return (ARR);
- calculate NPV, IRR, the payback period and ARR;
- justify the superiority of NPV over the IRR;
- explain the limitations of payback and ARR;
- justify why the payback and ARR methods are widely used in practice.

machinery, research and development, advertising and warehouse facilities. Investment decisions in the public sector include new roads, schools and airports. Individuals' investment decisions include house-buying and the purchase of consumer durables. In this chapter we shall examine the economic evaluation of the desirability of investment proposals. We shall concentrate on the investment decisions of business firms, but the same principles, with modifications, apply to individuals, and the public sector.

The opportunity cost of an investment

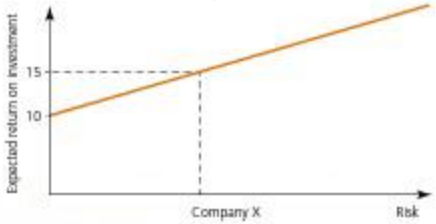
You will recall that in Chapter 1 we adopted the view that broadly firms seek to maximize the present value of future net cash inflows. It is therefore important that you acquire an understanding of the terms 'opportunity cost of an investment' and 'present value'. Investors can invest in securities traded in financial markets. If you prefer to avoid risk, you can invest in government securities, which will yield a *fixed* return. On the other hand, you may prefer to invest in *risky* securities such as the ordinary shares of companies quoted on the stock exchange. If you invest in the ordinary shares of a company, you will find that the return will vary from year to year, depending on the performance of the company and its future expectations. Investors normally prefer to avoid risk if possible, and will generally invest in risky securities only if they believe that they will obtain a greater return for the increased risk. Suppose that **risk-free gilt-edged securities** issued by the government yield a return of 10%. You will therefore be prepared to invest in ordinary shares only if you expect the return to be greater than 10%; let us assume that you require an *expected* return of 15% to induce you to invest in ordinary shares in preference to a risk-free security.

Suppose you invest in company X ordinary shares. Would you want company X to invest your money in a capital project that gives less than 15%? Surely not, assuming the project has the same risk as the alternative investments in shares of other companies that are yielding a return of 15%. You would prefer company X to invest in other companies' ordinary shares at 15% or, alternatively, to repay your investment so that you could invest yourself at 15%.

The rates of return that are available from investments in securities in financial markets such as ordinary shares and government gilt-edged securities represent the **opportunity cost of an investment** in capital projects; that is, if cash is invested in the capital project, it cannot be invested elsewhere to earn a return. A firm should therefore invest in capital projects only if they yield a return in excess of the opportunity cost of the investment. The opportunity cost of the investment is also known as the **minimum required rate of return**, **cost of capital**, **discount rate** or **interest rate**.

The return on securities traded in financial markets provides us with the opportunity costs, that is the required rates of return available on securities. The expected returns that investors require from the ordinary shares of different companies vary because some companies' shares are more risky than others. The greater the risk, the greater the expected returns. Consider Figure 15.1. You can see that as the risk of a security increases the return that investors require to compensate for the extra risk increases. Consequently, investors will expect to receive a return in excess of 15% if they invest in securities that have a higher risk than company X ordinary shares. If this return was not forthcoming, investors would not purchase high-risk securities. It is therefore important that companies investing in high-risk capital projects earn higher returns to compensate investors for this risk. You can also see that a risk-free security

FIGURE 15.1 *Risk–return trade-off*



such as a gilt-edged government security yields the lowest return, i.e. 10%. Consequently, if a firm invests in a project with zero risk, it should earn a return in excess of 10%. If the project does not yield this return and no other projects are available then the funds earmarked for the project should be repaid to the shareholders as dividends. The shareholders could then invest the funds themselves at 10%.

Compounding and discounting

Our objective is to calculate and compare returns on an investment in a capital project with an alternative equal risk investment in securities traded in the financial markets. This comparison is made using a technique called **discounted cash flow (DCF)** analysis. Because a DCF analysis is the opposite of the concept of **compounding interest**, we shall initially focus on compound interest calculations.

Suppose you are investing £100 000 in a risk-free security yielding a return of 10% payable at the end of each year. Exhibit 15.1 shows that if the interest is reinvested, your investment will accumulate to £146 410 by the end of year 4. Period 0 in the first column of Exhibit 15.1 means that no time has elapsed or the time is *now*, period 1 means one year later, and so on. The values in Exhibit 15.1 can also be obtained by using the formula:

$$FV_n = V_0(1 + K)^n \tag{15.1}$$

where FV_n denotes the future value of an investment in n years, V_0 denotes the amount invested at the beginning of the period (year 0), K denotes the rate of return on the investment and n denotes the number of years for which the money is invested. The calculation for £100 000 invested at 10% for two years is

$$FV_2 = £100\,000\,(1 + 0.10)^2 = £121\,000$$

In Exhibit 15.1 all of the year-end values are equal as far as the time value of money is concerned. For example, £121 000 received at the end of year 2 is equivalent to £100 000 received today and invested at 10%. Similarly, £133 100 received at the end of year 3 is equivalent to £121 000 received at the end of year 2, since £121 000 can be invested at the end of year 2 to accumulate to £133 100. Unfortunately, none of the amounts

EXHIBIT 15.1

The value of £100 000 invested at 10%, compounded annually, for four years

End of year	Interest earned (£)	Total investment (£)
0		100 000
	0.10 × 100 000	10 000
1		110 000
	0.10 × 110 000	11 000
2		121 000
	0.10 × 121 000	12 100
3		133 100
	0.10 × 133 100	13 310
4		146 410

are directly comparable at any single moment in time, because each amount is expressed at a different point in time.

When making capital investment decisions, we must convert cash inflows and outflows for different years into a common value. This is achieved by converting the cash flows into their respective values at the same point in time. Mathematically, any point in time can be chosen, since all four figures in Exhibit 15.1 are equal to £100 000 at year 0, £110 000 at year 1, £121 000 at year 2, and so on. However, it is preferable to choose the point in time at which the decision is taken, and this is the present time or year 0. All of the values in Exhibit 15.1 can therefore be expressed in values at the present time (i.e. '**present value**') of £100 000.

The process of converting cash to be received in the future into a value at the present time by the use of an interest rate is termed **discounting** and the resulting present value is the **discounted present value**. Compounding is the opposite of discounting, since it is the future value of present value cash flows. Equation (15.1) for calculating future values can be rearranged to produce the present value formula:

$$V_0 \text{ (present value)} = \frac{FV_n}{(1+K)^n} \qquad (15.2)$$

By applying this equation, the calculation for £121 000 received at the end of year 2 can be expressed as

$$\text{present value} = \frac{£121\,000}{(1+0.10)^2} = £100\,000$$

You should now be aware that £1 received today is not equal to £1 received one year from today. No rational person will be equally satisfied with receiving £1 a year from now as opposed to receiving it today, because money received today can be used to earn interest over the ensuing year. Thus one year from now an investor can have the original £1 plus one year's interest on it. For example, if the interest rate is 10% each £1 invested now will yield £1.10 one year from now. That is, £1 received today is equal to £1.10 one year from today at 10% interest. Alternatively, £1 one year from today is equal to £0.9091 today, its present value because £0.9091, plus 10% interest for one year amounts to £1. The concept that £1 received in the future is not equal to £1 received today is known as the **time value of money**.

We shall now consider four different methods of appraising capital investments: the net present value, internal rate of return, profitability index, accounting rate of return and payback methods. We shall see that the first two methods take into account the time value of money whereas the accounting rate of return and payback methods ignore this factor.

The concept of net present value

By using discounted cash flow techniques and calculating present values, we can compare the return on an investment in capital projects with an alternative equal risk investment in securities traded in the financial market. Suppose a firm is considering four projects (all of which are risk-free) shown in Exhibit 15.2. You can see that each of the projects is identical with the investment in the risk-free security shown in Exhibit 15.1 because you can cash in this investment for £110 000 in year 1, £121 000 in year 2, £133 100 in year 3 and £146 410 in year 4. In other words your potential cash receipts from the risk-free security are identical to the net cash flows for projects A, B, C and D shown in Exhibit 15.2. Consequently, the firm should be indifferent as to whether it uses the funds to invest in the projects or invests the funds in securities of identical risk traded in the financial markets.

The most straightforward way of determining whether a project yields a return in excess of the alternative equal risk investment in traded securities is to calculate the **net present value (NPV)**. This is the present value of the net cash inflows less the project's initial investment outlay. If the rate of return from the project is greater than the return from an equivalent risk investment in securities traded in the financial market, the NPV will be positive. Alternatively, if the rate of return is lower, the NPV will be negative. A positive NPV therefore indicates that an investment should be accepted, while a negative value indicates that it should be rejected. A zero NPV calculation indicates that the firm should be indifferent to whether the project is accepted or rejected.

You can see that the present value of each of the projects shown in Exhibit 15.2 is £100 000. You should now deduct the investment cost of £100 000 to calculate the project's NPV. The NPV for each project is zero. The firm should therefore be indifferent to whether it accepts any of the projects or invests the funds in an equivalent risk-free security. This was our conclusion when we compared the cash flows of the projects with the investments in a risk-free security shown in Exhibit 15.1.

You can see that it is better for the firm to invest in any of the projects shown in Exhibit 15.2 if their initial investment outlays are less than £100 000. This is because we have to pay £100 000 to obtain an equivalent stream of cash flows from a security traded in the financial markets. Conversely, we should reject the investment in the projects if their initial investment outlays are greater than £100 000. You should now see that the NPV rule leads to a direct comparison of a project with an equivalent risk security traded in the financial market. Given that the present value of the net cash inflows for each project is £100 000, their NPVs will be positive (thus signifying acceptance) if the initial investment outlay is less than £100 000 and negative (thus signifying rejection) if the initial outlay is greater than £100 000.

EXHIBIT 15.2
Evaluation of four risk-free projects

	A (£)	B (£)	C (£)	D (£)
Project investment outlay	100 000	100 000	100 000	100 000
End of year cash flows:				
Year 1	110 000	0	0	0
2	0	121 000	0	0
3	0	0	133 100	0
4	0	0	0	146 410
present value =	110 000 / 1.10	121 000 / $(1.10)^2$	133 000 / $(1.10)^3$	146 410 / $(1.10)^4$
	= 100 000	= 100 000	= 100 000	= 100 000

Calculating net present values

You should now have an intuitive understanding of the NPV rule. We shall now learn how to calculate NPVs. The NPV can be expressed as:

$$\text{NPV} = \frac{FV_1}{1+K} + \frac{FV_2}{(1+K)^2} + \frac{FV_3}{(1+K)^3} + \cdots + \frac{FV_n}{(1+K)^n} - I_0 \qquad (15.3)$$

where I_0 represents the investment outlay and FV represents the future values received in years 1 to n. The rate of return K used is the return available on an equivalent risk security in the financial market. Consider the situation in Example 15.1.

The net present value calculation for Project A is:

$$\text{NPV} = \frac{£300\,000}{(1.10)} + \frac{£1\,000\,000}{(1.10)^2} + \frac{£400\,000}{(1.10)^3} - £1\,000\,000 = +£399\,700$$

Alternatively, the net present value can be calculated by referring to a published table of present values. You will find examples of such a table if you refer to Appendix A (see page 544). To use the table, simply find the discount factors by referring to each year of the cash flows and the appropriate interest rate.

For example, if you refer to year 1 in Appendix A, and the 10% column, this will show a discount factor of 0.9091. For years 2 and 3 the discount factors are 0.8264 and 0.7513. You then multiply the cash flows by the discount factors to find the present value of the cash flows. The calculation is as follows:

Year	Amount (£000's)	Discount factor	Present value (£)
1	300	0.9091	272 730
2	1000	0.8264	826 400
3	400	0.7513	300 520
			1 399 650
		Less initial outlay	1 000 000
		Net present value	399 650

The difference between the two calculations is due to rounding differences.

EXAMPLE 15.1

The Bothnia Company is evaluating two projects with an expected life of three years and an investment outlay of £1 million. The estimated net cash inflows for each project are as follows:

	Project A (£)	Project B (£)
Year 1	300 000	600 000
Year 2	1 000 000	600 000
Year 3	400 000	600 000

The opportunity cost of capital for both projects is 10%. You are required to calculate the net present value for each project.

Note that the discount factors in the present value table are based on £1 received in n years time calculated according to the present value formula (equation 15.2). For example, £1 received in years 1, 2 and 3 when the interest rate is 10% is calculated as follows:

$$\text{Year 1} = £1/1.10 = 0.9091$$
$$\text{Year 2} = £1(1.10)^2 = 0.8264$$
$$\text{Year 3} = £1(1.10)^3 = 0.7513$$

The positive net present value from the investment indicates the increase in the market value of the shareholders' funds which should occur once the stock market becomes aware of the acceptance of the project. The net present value also represents the potential increase in present consumption that the project makes available to the ordinary shareholders, after any funds used have been repaid with interest. For example, assume that the firm finances the investment of £1 million in Example 15.1 by borrowing £1 399 700 at 10% and repays the loan and interest out of the project's proceeds as they occur. You can see from the repayment schedule in Exhibit 15.3 that £399 700 received from the loan is available for current consumption, and the remaining £1 000 000 can be invested in the project. The cash flows from the project are just sufficient to repay the loan. Therefore acceptance of the project enables the ordinary shareholders' present consumption to be increased by the net present value of £399 700. Hence the acceptance of all available projects with a positive net present value should lead to the maximization of shareholders' wealth.

Let us now calculate the net present value for Project B shown in Example 15.1 The cash flows for project B represent an **annuity**. An annuity is an asset that pays a fixed sum each period for a specific number of periods. You can see for Project B that the cash flows are £600 000 per annum for three years. When the annual cash flows are equivalent to an annuity, the calculation of net present value is simplified. The discount factors for an annuity are set out in Appendix B (see page 545). We need to find the discount factor for 10% for three years. If you refer to Appendix B, you will see that it is 2.487. The NPV is calculated as follows:

EXHIBIT 15.3

The pattern of cash flows assuming that the loan is repaid out of the proceeds of the project

Year	Loan outstanding at start of year (1) (£)	Interest at 10% (2) (£)	Total amount owed before repayment (3) = (1) + (2) (£)	Proceeds from project (4) (£)	Loan outstanding at year end (5) = (3) – (4) (£)
1	1 399 700	139 970	1 539 670	300 000	1 239 670
2	1 239 670	123 967	1 363 637	1 000 000	363 637
3	363 637	36 363	400 000	400 000	0

Annual cash inflow	Discount factor	Present value (£)
£600 000	2.487	1 492 200
	Less investment cost	1 000 000
	Net present value	492 200

You will see that the total present value for the period is calculated by multiplying the cash inflow by the discount factor. It is important to note that the annuity tables shown in Appendix B can only be applied when the annual cash flows are the same each year. Annuities are also based on the assumption that cash flows for the first period are received at the end of the period, and not at the start of the period, and that all subsequent cash flows are received at the end of each period. Note that the discount factors shown in Appendix B are derived from the following formula for an annuity:

$$\text{Present value} = \frac{A}{r}\left(1 - \frac{1}{(1+r)^n}\right) \qquad (15.4)$$

where A is the annuity amount and r (also denoted by K) is the interest/discount rate per period.

Therefore the annuity factor for the present value for £1 received in each of three periods at a cost of capital (discount rate) of 10% is:

$$\text{PV} = \frac{£1}{0.10}\left(1 - \frac{1}{(1+0.10)^3}\right) = 10\,(0.24868) = 2.487$$

Sometimes, to simplify the calculations, examination questions are set based on the assumption that constant cash flows occur into perpetuity. In this situation the present value is determined by dividing the cash flow by the discount rate. For example, the present value of a cash flow of £100 per annum into perpetuity at a discount rate of 10% is £1000 (£100/0.10). Again the present value calculation is based on the assumption that the first cash flow is received one period hence.

The internal rate of return

The **internal rate of return (IRR)** is an alternative technique for use in making capital investment decisions that also takes into account the time value of money. The internal

rate of return represents the true interest rate earned on an investment over the course of its economic life. This measure is sometimes referred to as the **discounted rate of return**. The internal rate of return is the interest rate K that when used to discount all cash flows resulting from an investment, will equate the present value of the cash receipts to the present value of the cash outlays. In other words, it is the discount rate that will cause the net present value of an investment to be zero. Alternatively, the internal rate of return can be described as the maximum cost of capital that can be applied to finance a project without causing harm to the shareholders. The internal rate of return is found by solving for the value of K from the following formula:

$$I_0 = \frac{FV_1}{1+K} + \frac{FV_2}{(1+K)^2} + \frac{FV_3}{(1+K)^3} + \cdots + \frac{FV_n}{(1+K)^n} \qquad (15.5)$$

It is easier, however, to use the discount tables. Let us now calculate the internal rate of return for Project A in Example 15.1.

The IRR can be found by trial and error by using a number of discount factors until the NPV equals zero. For example, if we use a 25% discount factor, we get a positive NPV of £84 800. We must therefore try a higher figure. Applying 35% gives a negative NPV of £66 530. We know then that the NPV will be zero somewhere between 25% and 35%. In fact, the IRR is approximately 30%, as indicated in the following calculation:

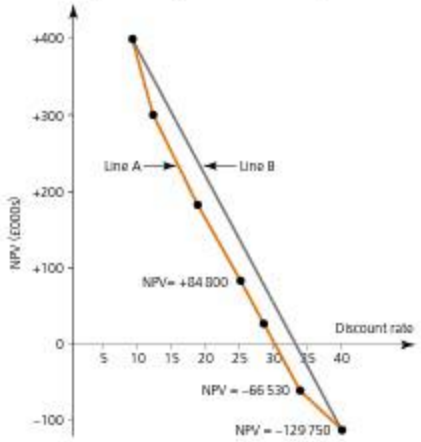
Year	Net cash flow (£)	Discount factor (30%)	Present value of cash flow (£)
1	300 000	0.7692	230 760
2	1 000 000	0.5917	591 700
3	400 000	0.4552	182 080
		Net present value	1 004 540
		Less initial outlay	1 000 000
		Net present value	4 540

It is claimed that the calculation of the IRR does not require the prior specification of the cost of capital. The decision rule is that if the IRR is greater than the opportunity cost of capital, the investment is profitable and will yield a positive NPV. Alternatively, if the IRR is less than the cost of capital, the investment is unprofitable and will result in a negative NPV. Therefore any interpretation of the significance of the IRR will still require that we estimate the cost of capital. The calculation of the IRR is illustrated in Figure 15.2.

The dots in the graph represent the NPV at different discount rates. The point where the line joining the dots cuts the horizontal axis indicates the IRR (the point at which the NPV is zero). Figure 15.2 indicates that the IRR is 30%, and you can see from this diagram that the interpolation method can be used to calculate the IRR without carrying out trial and error calculations. When we use interpolation, we infer the missing term (in this case the discount rate at which NPV is zero) from a known series of numbers. For example, at a discount rate of 25% the NPV is +£84 800 and for a discount rate of 35% the NPV is −£66 530. The total distance between these points is £151 330 (+£84 800 and −£66 530). The calculation for the approximate IRR is therefore

$$25\% + \frac{84\,800}{151\,330} \times (35\% - 25\%) = 30.60\%$$

FIGURE 15.2 *Interpretation of the internal rate of return*



In other words, if you move down line A in Figure 15.2 from a discount rate of 25% by £84 800, you will reach the point at which NPV is zero. The distance between the two points on line A is £151 330, and we are given the discount rates of 25% and 35% for these points. Therefore 84 800/151 330 represents the distance that we must move between these two points for the NPV to be zero. This distance in terms of the discount rate is 5.60% [(84 800/151 330) × 10%], which, when added to the starting point of 25%, produces an IRR of 30.60%. The formula using the interpolation method is as follows:

$$A + \frac{C}{C-D}(B-A) \tag{15.6}$$

where A is the discount rate of the low trial, B is the discount rate of the high trial, C is the NPV of cash inflow of the low trial and D is the NPV of cash inflow of the high trial. Thus

$$\begin{aligned} &25\% + \left[\frac{84\,800}{84\,800-(-66\,530)} \times 10\%\right] \\ &= 25\% + \left[\frac{84\,800}{151\,330} \times 10\%\right] \\ &= 30.60\% \end{aligned}$$

Note that the interpolation method only gives an approximation of the IRR. The greater the distance between any two points that have a positive and a negative NPV,

the less accurate is the IRR calculation. Consider line B in Figure 15.2 derived from discount rates of 10% and 40%. The point where it cuts the horizontal axis is approximately 33%, whereas the actual IRR is 30.60%.

The calculation of the IRR is easier when the cash flows are of a constant amount each year. Let us now calculate the internal rate of return for project B in Example 15.1. Because the cash flows are equal each year, we can use the annuity table in Appendix B. When the cash flows are discounted at the IRR, the NPV will be zero. The IRR will therefore be at the point where

$$[\text{annual cash flow}] \times \begin{bmatrix}\text{discount factor for number of years}\\ \text{for which cash flow is received}\end{bmatrix} - \begin{bmatrix}\text{investment}\\ \text{cost}\end{bmatrix} = 0$$

Rearranging this formula, the internal rate of return will be at the point where

$$\text{discount factor} = \frac{\text{investment cost}}{\text{annual cash flow}}$$

Substituting the figures for project B in Example 15.1,

$$\text{discount factor} = \frac{£1\,000\,000}{£600\,000} = 1.666$$

We now examine the entries for the year 3 row in Appendix B to find the figures closest to 1.666. They are 1.673 (entered in the 36% column) and 1.652 (entered in the 37% column). We can therefore conclude that the IRR is between 36% and 37%. However, because the cost of capital is 10%, an accurate calculation is unnecessary; the IRR is far in excess of the cost of capital.

The calculation of the IRR can be rather tedious (as the cited examples show), but the trial-and-error approach can be programmed for fast and accurate solution by a computer or calculator. The calculation problems are no longer a justification for preferring the NPV method of investment appraisal. Nevertheless, there are theoretical justifications, that support the NPV method.

Relevant cash flows

Investment decisions, like all other decisions, should be analysed in terms of the cash flows that can be directly attributable to them. These cash flows should include the incremental cash flows that will occur in the future following acceptance of the investment. The cash flows will include cash inflows and outflows, or the inflows may be represented by savings in cash outflows. For example, a decision to purchase new machinery may generate cash savings in the form of reduced out-of-pocket operating costs. For all practical purposes such cost savings are equivalent to cash receipts.

It is important to note that depreciation is not included in the cash flow estimates for capital investment decisions, since it is a non-cash expense. This is because the capital investment cost of the asset to be depreciated is included as a cash outflow at the start of the project, and depreciation is merely a financial accounting method for allocating past capital costs to future accounting periods. Any inclusion of depreciation will lead to double counting.

Timing of cash flows

To simplify the presentation our calculations have been based on the assumption that any cash flows in future years will occur in one lump sum at the year end. Obviously, this is an unrealistic assumption, since cash flows are likely to occur at various times throughout the year, and a more realistic assumption is to assume that cash flows occur at the end of each month and use monthly discount rates. Typically, discount and interest rates are quoted as rates per annum using the term **annual percentage rate (APR)**. If you wish to use monthly discount rates it is necessary to convert annual discount rates to monthly rates. An approximation of the monthly discount rate can be obtained by dividing the annual rate by 12. However, this simplified calculation ignores the compounding effect whereby each monthly interest payment is reinvested to earn more interest each month. To convert the annual discount rate to a monthly discount rate that takes into account the compounding effect we must use the following formula:

$$\text{Monthly discount rate} = ({}_{12}\sqrt{1 + \text{APR}}) - 1 \qquad (15.7)$$

Assume that the annual percentage discount rate is 12.68%. Applying formula 15.7 gives a monthly discount rate of:

$$({}_{12}\sqrt{1.1268}) - 1 = 1.01 - 1 = .01 \text{ (i.e. 1\% per month).}$$

Therefore the monthly cash flows would be discounted at 1%. In other words, 1% compounded monthly is equivalent to 12.68% compounded annually. Note that the monthly discount rates can also be converted to annual percentage rates using the formula:

$$(1 + k)^{12} - 1 \text{ (where k = the monthly discount rate)} \qquad (15.8)$$

Assuming a monthly rate of 1% the annual rate is $(1.01)^{12} - 1 = 0.1268$ (i.e. 12.68% per annum).

Techniques that ignore the time value of money

In addition to those methods that take into account the time value of money two other methods that ignore this factor are frequently used in practice. These are the payback method and the accounting rate of return method. Methods that ignore the time value of money are theoretically weak, and they will not necessarily lead to the maximization of the market value of ordinary shares. Nevertheless, the fact that they are frequently used in practice means that we should be aware of these techniques and their limitations.

Payback method

The **payback method** is one of the simplest and most frequently used methods of capital investment appraisal. It is defined as the length of time that is required for a stream of cash proceeds from an investment to recover the original cash outlay required by the investment. If the stream of cash flows from the investment is constant



Investment appraisal at Cyto Technologies

Cyto Technologies[1] is a rapidly growing biotechnology company in the USA that manufactures and sells hundreds of products. In the past, the project selection process at Cyto lacked a structured approach. Projects were selected with just sketchy ideas about financial numbers and rough ideas of payback periods. Increasing competition and the higher cost of capital have forced Cyto to change its approach. A project approval team was set up to provide structure for the project development and evaluation process. It consists of five constant members (the heads of manufacturing, quality assurance, finance, marketing and research and development). The team oversees the allocation of resources to new projects in alignment with the company's objectives.

The new project development and evaluation process consists of four phases. Phase 1 consists of two stages: idea generation and investigation. In the generation stage any R&D scientist with an idea for a new product or technique is granted a small sum of money to undertake initial research. The idea is documented in an idea evaluation report and screened by marketing and R&D. If the idea appears promising, it enters the investigation stage, which results in a proposal, and the project is reviewed by members of the project approval team.

Phase 2, product design, consists of a feasibility study. The study results in a report on the final definition of the product – image, specifications, marketing potential and initial estimates of the return on investment and IRR. Once again the report is reviewed by the project appraisal team and a favourable review moves the project to the next phase.

Phase 3, product development consists of two stages: specifications and final optimization. In the specifications stage production cost estimates are established and marketing personnel determine the final sales forecasts. Final appraisal estimates of the payback period, NPV and IRR are computed. At this point the project evaluation team to once again review the project, which if approved, enters the final optimization stage. Financial performance is one of nine criteria used by the project evaluation team to evaluate projects so a project may be approved even if it performs relatively poorly on that test. Examples of non-financial criteria include the potential for spin-off products, strategic fit within the planned and existing activities and the impact on long-term corporate positioning. During the optimization stage the first batch is made, quality assurance specifications are detailed, regulatory compliances are met, and the final design is demonstrated. The marketing personnel are involved in planning product promotion and advertising campaigns. Finally, in phase 4, the product is launched.

Note:
[1] The company name has been changed at the request of management.

Source: Kalagnanam, S. and Schmidt, S. K. (1996), Analyzing capital investments in new products, *Management Accounting (USA)*, January, pp. 31–6.

each year, the payback period can be calculated by dividing the total initial cash outlay by the amount of the expected annual cash proceeds. Therefore if an investment requires an initial outlay of £60 000 and is expected to produce annual cash inflows of £20 000 per year for five years, the payback period will be £60 000 divided by £20 000, or three years. If the stream of expected proceeds is not constant from year to year, the

payback period is determined by adding up the cash inflows expected in successive years until the total is equal to the original outlay. Example 15.2 illustrates two projects, A and B, that require the same initial outlay of £50 000 but that display different time profiles of benefits.

In Example 15.2 project A pays back its initial investment cost in three years, whereas project B pays back its initial cost in four years so that project A would be ranked in preference to project B. However, project B has a higher NPV, and the payback method incorrectly ranks project A in preference to project B. Two obvious deficiencies are apparent from these calculations. First, the payback method does not take into account cash flows that are earned after the payback period and, secondly, it fails to take into account the differences in the timing of the proceeds which are earned before the payback period. Payback computations ignore the important fact that future cash receipts cannot be validly compared with an initial outlay until they are discounted to their present values.

Not only does the payback period incorrectly rank project A in preference to project B, but the method can also result in the acceptance of projects that have a negative NPV. Consider the cash flows for project C in Example 15.3.

The payback period for project C is three years, and if this was within the time limit set by management, the project would be accepted in spite of its negative NPV. Note also that the payback method would rank project C in preference to project B in Example 15.2, despite the fact that B would yield a positive NPV.

The payback period can only be a valid indicator of the time that an investment requires to pay for itself, if all cash flows are first discounted to their present values and the discounted values are then used to calculate the payback period. This adjustment gives rise to what is known as the adjusted or **discounted payback method**. Even when such an adjustment is made, the adjusted payback method cannot be a complete measure of an investment's profitability. It can estimate whether an investment is likely to be profitable, but it cannot estimate how profitable the investment will be.

Despite the theoretical limitations of the payback method it is the method most widely used in practice (see Exhibit 15.4). Why, then, is payback the most widely applied formal investment appraisal technique? It is a particularly useful approach for ranking projects where a firm faces liquidity constraints and requires a fast repayment of investments. The payback method may also be appropriate in situations where risky investments are made in uncertain markets that are subject to fast design and product changes or where future cash flows are extremely difficult to predict. The payback method assumes that risk is time-related: the longer the period, the greater the chance of failure. By concentrating on the early cash flows, payback uses data in which managers have greater confidence. Thus, the payback period can be used as a rough measure of risk, based on the assumption that the longer it takes for a project to pay for itself, the riskier it is. Managers may also choose projects with quick payback periods because of self-interest. If a manager's performance is measured using short-term criteria, such as net profits, there is a danger that he or she may choose projects with quick paybacks to show improved net profits as soon as possible. The payback method is also frequently used in conjunction with the NPV or IRR methods. It serves as a simple first-level screening device that identifies those projects that should be subject to more rigorous investigation. A further attraction of payback is that it is easily understood by all levels of management and provides an important summary measure: how quickly will the project recover its initial outlay? Ideally, the payback method should be used in conjunction with the NPV method, and the cash flows discounted before the payback period is calculated.

EXAMPLE 15.2

The cash flows and NPV calculations for two projects are as follows:

	Project A		Project B	
	(£)	(£)	(£)	(£)
Initial cost				
Net cash inflows		50 000		50 000
Year 1	10 000		10 000	
Year 2	20 000		10 000	
Year 3	20 000		10 000	
Year 4	20 000		20 000	
Year 5	10 000		30 000	
Year 6	–		30 000	
Year 7	–	80 000	30 000	140 000
NPV at a 10% cost capital		10 500		39 460

EXAMPLE 15.3

The cash flows and NPV calculation for project C are as follows:

	(£)	(£)
Initial cost		
Net cash inflows		50 000
Year 1	10 000	
Year 2	20 000	
Year 3	20 000	
Year 4	3 500	
Year 5	3 500	
Year 6	3 500	
Year 7	3 500	64 000
NPV (at 10% cost of capital)		(–1 036)

It is apparent from various surveys that firms use a combination of appraisal methods. The studies by Pike (1996) indicate a trend in the increasing usage of discount rates. The Drury *et al.* study suggests that larger organizations use net present value and internal rate of return to a greater extent than the smaller organizations. The Drury *et al.* (1993) study also asked the respondents to rank the appraisal methods in order of importance for evaluating major projects. The larger organizations ranked internal rate of return first, followed by payback and net present value whereas the smaller organizations ranked payback first, internal rate of return second and intuitive management judgement third.

The use of the accounting rate of return probably reflects the fact that it is a widely used external financial accounting measure by financial markets and managers therefore wish to assess what impact a project will have on the external reporting of this measure. Also it is a widely used measure for evaluating managerial performance.

EXHIBIT 15.4
Surveys of practice

Surveys conducted by Pike relating to the investment appraisal techniques by 100 large UK companies between 1975 and 1992 provide an indication of the changing trends in practice in large UK companies. Pike's findings relating to the percentage of firms using different appraisal methods are as follows:

	1975 %	1981 %	1986 %	1992 %
Payback	73	81	92	94
Accounting rate of return	51	49	56	50
DCF methods (IRR or NPV)	58	68	84	88
Internal rate of return (IRR)	44	57	75	81
Net present value (NPV)	32	39	68	74

Source: Pike (1996)

A study of 300 UK manufacturing organizations by Drury *et al.* (1993) sought to ascertain the extent to which particular techniques were used. The figures below indicate the percentage of firms that often or always used a particular technique:

	All organizations %	Smallest organizations %	Largest organizations %
Payback (unadjusted)	63	56	55
Discounted payback	42	30	48
Accounting rate of return	41	35	53
Internal rate of return	57	30	85
Net present value	43	23	80

More recently a UK study by Arnold and Hatzopoulos (2000) reported that NPV has overtaken IRR as the most widely used method by larger firms. They reported that 97% of large firms use NPV compared with 84% which employ IRR.

Few studies have been undertaken in mainland Europe. The following usage rates relate to surveys undertaken in the USA and Belgium. For comparative purposes Pike's UK study is also listed:

	UK[a] %	USA[b] %	Belgium[c] %
Payback	94	72	50
Accounting rate of return	50	65	65
Internal rate of return	81	91	77
Net present value	74	88	60
Discounted payback		65	68

[a] Pike (1996)
[b] Trahan and Gitman (1995)
[c] Dardenne (1998)

Accounting rate of return

The **accounting rate of return** (also known as the **return on investment** and **return on capital employed**) is calculated by dividing the average annual profits from a project into the average investment cost. It differs from other methods in that profits rather than cash flows are used. Note that profits are not equal to cash flows because financial accounting profit measurement is based on the accruals concept. Assuming that depreciation represents the only non-cash expense, profit is equivalent to cash flows less depreciation. The use of accounting rate of return can be attributed to the wide use of the return on investment measure in financial statement analysis.

When the average annual net profits are calculated, only additional revenues and costs that follow from the investment are included in the calculation. The average annual net profit is therefore calculated by dividing the difference between incremental revenues and costs by the estimated life of the investment. The incremental costs include either the *net* investment cost or the total depreciation charges, these figures being identical. The average investment figure that is used in the calculation depends on the method employed to calculate depreciation. If straight-line depreciation is used, it is presumed that investment will decline in a linear fashion as the asset ages. The average investment under this assumption is one-half of the amount of the initial investment plus one-half of the scrap value at the end of the project's life.[1]

For example, the three projects described in Examples 15.2 and 15.3 for which the payback period was computed required an initial outlay of £50 000. If we assume that the projects have no scrap values and that straight-line depreciation is used, the average investment for each project will be £25 000. The calculation of the accounting rate of return for each of these projects is as follows:

$$\text{accounting rate of return} = \frac{\text{average annual profits}}{\text{average investment}}$$

$$\text{project A} = \frac{6\,000}{25\,000} = 24\%$$

$$\text{project B} = \frac{12\,857}{25\,000} = 51\%$$

$$\text{project C} = \frac{2\,000}{25\,000} = 8\%$$

For project A the total profit over its five-year life is £30 000 (£80 000 – £50 000), giving an average annual profit of £6000. The average annual profits for projects B and C are calculated in a similar manner.

It follows that the accounting rate of return is superior to the payback method in one respect; that is, it allows for differences in the useful lives of the assets being compared. For example, the calculations set out above reflect the high earnings of project B over the whole life of the project, and consequently it is ranked in preference to project A. Also, projects A and C have the same payback periods, but the accounting rate of return correctly indicates that project A is preferable to project C.

However, the accounting rate of return suffers from the serious defect that it ignores the time value of money. When the method is used in relation to a project where the cash inflows do not occur until near the end of its life, it will show the same

accounting rate of return as it would for a project where the cash inflows occur early in its life, providing that the average cash inflows are the same. For this reason the accounting rate of return cannot be recommended. Nevertheless, the accounting rate of return is widely used in practice (see Exhibit 15.4). This is probably due to the fact that the annual accounting rate of return is frequently used to measure the managerial performance of different business units within a company. Therefore, managers are likely to be interested in how any new investment contributes to the business unit's overall accounting rate of return.

Qualitative factors

Not all investment projects can be described completely in terms of monetary costs and benefits (e.g. a new cafeteria for the employees or the installation of safety equipment). Nevertheless, the procedures described in this chapter may be useful by making the value placed by management on quantitative factors explicit. For example, if the present value of the cash outlays for a project is £100 000 and the benefits from the project are difficult to quantify, management must make a value judgement as to whether or not the benefits are in excess of £100 000. In the case of capital expenditure on facilities for employees, or expenditure to avoid unpleasant environmental effects from the company's manufacturing process, one can take the view that the present value of the cash outlays represents the cost to shareholders of the pursuit of goals other than the maximization of shareholders' funds. In other words, ordinary shareholders, as a group in the bargaining coalition, should know how much the pursuit of other goals is costing them.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain the opportunity cost of an investment.**

  The rates of return that are available from investments in financial markets in securities with different levels of risk (e.g. company shares, company and government bonds) represent the opportunity cost of an investment. In other words, if cash is invested in a capital project it cannot be invested elsewhere to earn a return. A firm should therefore only invest in projects that yield a return in excess of the opportunity cost of investment.

- **Distinguish between compounding and discounting.**

  The process of converting cash invested today at a specific interest rate into a future value is known as compounding. Discounting is the opposite of compounding and refers to the process of converting cash to be received in the future into the value at the present time. The resulting present value is called the discounted present value.

- **Explain the concepts of net present value (NPV), internal rate of return (IRR), payback method and accounting rate of return (ARR).**

  Both NPV and IRR are methods of determining whether a project yields a return in excess of an equal risk investment in traded financial securities. A positive NPV

provides an absolute value of the amount by which an investment exceeds the return available from an alternative investment in financial securities of equal risk. Conversely, a negative value indicates the amount by which an investment fails to match an equal risk investment in financial securities. In contrast, the IRR indicates the true percentage return from an investment after taking into account the time value of money. To ascertain whether an investment should be undertaken, the percentage internal rate of return on investment should be compared with the returns available from investing in equal risk in financial securities. Investing in all projects that have positive NPV's or IRR's in excess of the opportunity cost of capital should maximize shareholder value. The payback method is the length of time that is required for a stream of cash proceeds from an investment to recover the original cash outflow required by the investment. The ARR expresses the annual average profits arising from a project as a percentage return on the average investment required for the project.

- **Calculate NPV, IRR, the payback period and ARR.**

  The NPV is calculated by discounting the net cash inflows from a project and deducting the investment outlay. The IRR is calculated by ascertaining the discount rate that will cause the NPV of a project to be zero. The payback period is calculated by adding up the cash flows expected in successive years until the total is equal to the original outlay. The ARR is calculated by dividing the average annual profits estimated from a project by the average investment cost. The calculation of NPV and IRR was illustrated using Example 15.1 and Examples 15.4 and 15.5 were used to illustrate the calculations of the payback period and the ARR.

- **Explain the limitations of payback and ARR.**

  The major limitations of the payback method are that it ignores the time value of money and it does not take into account the cash flows that are earned after the payback period. The ARR also fails to take into account the time value of money and relies on a percentage return rather than an absolute value.

- **Justify why the payback and ARR methods are widely used in practice.**

  The payback method is frequently used in practice because (a) it is considered useful when firms face liquidity constraints and require a fast repayment of their investments; (b) it serves as a simple first-level screening device that identifies those projects that should be subject to more rigorous investigations; and (c) it provides a rough measure of risk, based on the assumption that the longer it takes for a project to pay for itself, the riskier it is. The ARR is a widely used financial accounting measure of managerial and company performance. Therefore, managers are likely to be interested in how any new investment contributes to the business unit's overall accounting rate of return.

- **Additional learning objective presented in Appendix 15.1**

  The appendix to this chapter includes the following additional learning objective: calculate the incremental taxation payments arising from a proposed investment. The cash flows from a project must be reduced by the amount of taxation payable on these cash flows. However, the taxation savings arising from the capital allowances (i.e. annual writing down allowances) reduce the taxation payments. Because taxation payments do not occur at the same time as the associated cash flows, the precise timing of the taxation payments should be identified to calculate NPV. You should refer to Appendix 15.1 for an illustration of the computation of the incremental taxation payment.

Appendix 15.1: Taxation and investment decisions

In our discussions so far we have ignored the impact of taxation. Taxation rules differ between countries but in most countries similar principles tend to apply relating to the taxation allowances available on capital investment expenditure. Companies rarely pay taxes on the profits that are disclosed in their annual published accounts, since certain expenses that are deducted in the published accounts are not allowable deductions for taxation purposes. For example, depreciation is not an allowable deduction; instead, taxation legislation enables **capital allowances** (also known as **writing-down allowances** or **depreciation tax shields**) to be claimed on capital expenditure that is incurred on plant and machinery and other fixed assets. Capital allowances represent standardized depreciation allowances granted by the tax authorities. These allowances vary from country to country but their common aim is to enable the *net* cost of assets to be deducted as an allowable expense, either throughout their economic life or on an accelerated basis which is shorter than an asset's economic life.

Taxation laws in different countries typically specify the amount of capital expenditure that is allowable (sometimes this exceeds the cost of the asset where a government wishes to stimulate investment), the time period over which the capital allowances can be claimed and the depreciation method to be employed. Currently in the UK, larger companies can claim annual capital allowances of 25% on the written-down value of plant and equipment based on the reducing balance method of depreciation. Different percentage capital allowances are also available on other assets such as industrial buildings where an allowance of 4% per annum based on straight line depreciation can be claimed.[2]

Let us now consider how taxation affects the NPV calculations. You will see that the calculation must include the incremental tax cash flows arising from the investment. Consider the information presented in Example 15A.1.

The first stage is to calculate the annual writing down allowances (i.e. the capital allowances). The calculations are as follows:

End of year	Annual writing-down allowance (£)	Written-down value (£)
0	0	1 000 000
1	250 000 (25% × £1 000 000)	750 000
2	187 500 (25% × £750 000)	562 500
3	140 630 (25% × £562 500)	421 870
4	105 470 (25% × £421 870)	316 400
	683 600	

Next we calculate the additional taxable profits arising from the project. The calculations are as follows:

	Year 1 (£)	Year 2 (£)	Year 3 (£)	Year 4 (£)
Incremental annual profits	500 000	500 000	500 000	500 000
Less annual writing-down allowance	250 000	187 500	140 630	105 470
Incremental taxable profits	250 000	312 500	359 370	394 530
Incremental tax at 35%	87 500	109 370	125 780	138 090

EXAMPLE 15A.1

The Sentosa Company operates in Ruratania where investments in plant and machinery are eligible for 25% annual writing-down allowances on the written-down value using the reducing balance method of depreciation. The corporate tax rate is 35%. The company is considering whether to purchase some machinery which will cost £1 million and which is expected to result in additional net cash inflows and profits of £500 000 per annum for four years. It is anticipated that the machinery will be sold at the end of year 4 for its written-down value for taxation purposes. Assume a one year lag in the payment of taxes. Calculate the net present value assuming a cost of capital of 10%.

You can see that for each year the incremental tax payment is calculated as follows:

$$\text{corporate tax rate} \times (\text{incremental profits} - \text{capital allowance})$$

Note that depreciation charges should not be included in the calculation of incremental cash flows or taxable profits. We must now consider the timing of the taxation payments. In the UK taxation payments vary depending on the end of the accounting year, but they are generally paid approximately one year after the end of the company's accounting year. We shall apply this rule to our example. This means that the tax payment of £87 500 for year 1 will be paid at the end of year 2, £109 370 tax will be paid at the end of year 3 and so on.

The incremental tax payments are now included in the NPV calculation:

Year	Cash flow (£)	Taxation	Net cash flow (£)	Discount factor	Present value (£)
0	−1 000 000	0	−1 000 000	1.0000	−1 000 000
1	+500 000	0	+500 000	0.9091	+454 550
2	+500 000	−87 500	+412 500	0.8264	+348 090
3	+500 000	−109 370	+390 630	0.7513	+293 480
4	+500 000 +316 400*	−125 780	+690 620	0.6830	+471 690
5	0	−138 090	−138 090	0.6209	−85 740
				Net present value	+482 070

*Sale of machinery for written down value of £316 400.

The taxation rules in most countries allow capital allowances to be claimed on the *net* cost of the asset. In our example the machine will be purchased for £1 million and the estimated realizable value at the end of its life is its written-down value of £316 400. Therefore the estimated net cost of the machine is £683 600. You will see from the above calculations of additional taxable profits that the total of the annual writing-down allowances (Row 2) amount to the net cost. How would the analysis change if the estimated realizable value for the machine was different from its written-down value, say £450 000? The company will have claimed allowances of £683 600 but the estimated net cost of the machine is £550 000 (£1 million − £450 000 estimated net realizable value). Therefore excess allowances of £133 600 (£683 600 − £550 000) will have been

claimed and an adjustment must be made at the end of year 4 so that the tax authorities can claim back the excess allowance. This adjustment is called a **balancing charge**.

Note that the above calculation of taxable profits for year 4 will now be as follows:

Incremental annual profits	500 000
Less annual writing-down allowance	(105 470)
Add balancing charge	133 600
Incremental taxable profits	528 130
Incremental taxation at 35%	184 845

An alternative calculation is to assume that a writing-down allowance will not be claimed in year 4. The balancing charge is now calculated by deducting the written-down value at the end of year 3 of £421 870 from the *actual* sales value at the time of sale (i.e. £450 000 sale proceeds). The balancing charge is now £28 130. This is the same as the net charge incorporated in the above calculation (£133 600 – £105 470 = £28 130). You can adopt either method. It is a matter of personal preference.

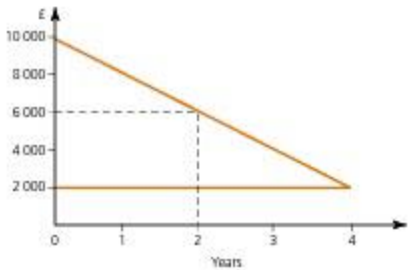
Let us now assume that the estimated disposal value is less than the written-down value for tax purposes, say £250 000. The net investment cost is £750 000 (£1 million – £250 000), but you will see that our calculations at the start of this section indicate that estimated taxation capital allowances of £683 600 will have been claimed by the end of year 4. Therefore an adjustment of £66 400 (£750 000 – £683 600) must be made at the end of year 4 to reflect the fact that insufficient capital allowances have been claimed. This adjustment is called a **balancing allowance**.

Thus in year 4 the total capital allowance will consist of an annual writing-down allowance of £105 470 plus a balancing allowance of £66 400, giving a total of £171 870. Taxable profits for year 4 are now £328 130 (500 000 – £171 870), and tax at the rate of 35% on these profits will be paid at the end of year 5.

Do note that in the UK, and some other countries, it is possible to combine similar types of assets into asset pools and purchases and sales of assets are added to the pool so that balancing allowances and charges on individual assets do not arise. However, similar outcomes are likely to occur. Accordingly, it is essential when appraising investment proposals to be fully aware of the specific taxation legislation that applies so that you can precisely determine the taxation impact. In most cases taxation is likely to have an important effect on the NPV calculation. For an illustration of the treatment of asset acquisitions and disposals when asset are incorporated into a general pool you should refer to the article by Franklin (1998).

Notes

1 Consider a project that costs £10 000 and has a life of four years and an estimated scrap value of £2000. The following diagram illustrates why the project's scrap value is added to the initial outlay to calculate the average capital employed. You can see that at the mid-point of the project's life the capital employed is equal to £6000 (i.e. ½ (10 000 + £2000)).



2 In 2005/6 the profits of UK companies were subject to a corporate tax rate of 30%. For small companies with annual profits of less than £300 000 the corporate tax rate was 19%.

Key terms and concepts

accounting rate of return (p. 407)
annual percentage rate (APR) (p. 402)
annuity (p. 397)
balancing allowance (p. 412)
balancing charge (p. 412)
capital allowance (p. 410)
compounding interest (p. 393)
cost of capital (p. 392)
depreciation tax shield (p. 410)
discounted cash flow (p. 393)
discounted payback method (p. 404)
discounted present value (p. 394)
discounted rate of return (p. 399)
discounting (p. 394)
discount rate (p. 392)
interest rate (p. 392)
internal rate of return (p. 398)
minimum required rate of return (p. 392)
net present value (p. 395)
opportunity cost of an investment (p. 392)
payback method (p. 402)
present value (p. 394)
return on capital employed (p. 407)
return on investment (p. 407)
risk-free gilt-edged securities (p. 392)
time value of money (p. 394)
writing-down allowance (p. 410)

Key examination points

A common mistake is a failure to distinguish between relevant and irrelevant cash flows. Remember to include only incremental cash flows in a discounted cash flow calculation. Depreciation and apportionments of overheads should not be included. Another common error is to use the wrong present value table. With unequal annual cash flows, use Appendix A (the discount factors will be less than 1), and if the cash flows are the same each year (i.e. they represent an annuity), use Appendix B (the discount factors will be greater than 1 from year 2 onwards).

Note that the examination questions set by the professional accountancy examining bodies normally provide you with the formulae for annuities for both present and future values. Sometimes examination questions require you to use formula 15.4, shown within the chapter, to determine the constant cash flow per period (i.e. the annuity amount) required to produce a given *present* value. You should refer to the answer to Review problem 15.21 for an illustration of how the annuity value is calculated. Examinations questions also require you to use the annuity formula for *future* values, rather than the present value formula presented in the text. The following future value annuity formula is normally provided:

$$\text{Future value} = A\left(\frac{(1+r)^n - 1}{r}\right)$$

where r (also denoted by k) is the rate of interest per period and A is the annuity amount.

Typical examination questions require you to calculate the future value of an annuity (see answers to Review problems 15.18 and 15.19) or the annuity value where the future value is given (see Review problems 15.20).



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. The Rawhide Development Company is a case that is relevant to the content of this chapter.

Review questions

15.1 What is meant by the opportunity cost of an investment? What role does it play in capital investment decisions? (*pp. 392–3*)

15.2 Distinguish between compounding and discounting. (*pp. 393–4*)

15.3 Explain what is meant by the term 'time value of money'. (*p. 394*)

15.4 Describe the concept of net present value (NPV). (*p. 395*)

15.5 Explain what is meant by the internal rate of return (IRR). (*pp. 398–9*)

15.6 Describe the payback method. What are its main strengths and weaknesses? (*pp. 402–5*)

15.7 Describe the accounting rate of return. What are its main strengths and weaknesses? (*pp. 407–8*)

15.8 Distinguish between the payback method and discounted payback method. (*p. 404*)

15.9 How does taxation affect the appraisal of capital investments? (*p. 410*)

15.10 Define writing-down-allowances (also known as depreciation tax shields or capital allowances), balancing allowances and balancing charges. (*pp. 410–2*)

Review problems

15.11 Dalby is currently considering an investment that gives a positive net present value of £3664 at 15%. At a discount rate of 20% it has a negative net present value of £21 451.

What is the internal rate of return of this investment?

A 15.7%
B 16.0%
C 19.3%
D 19.9%.

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15.12 Ayr is planning on paying £300 into a fund on a monthly basis starting 3 months from now, for 12 months. The interest earned will be at a rate of 3% per month.

What is the present value of these payments?

A £2816
B £2733
C £2541
D £2986.

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15.13 The statements below relate to the internal rate of return:

The internal rate of return

(i) calculates the highest possible net present value.
(ii) represents the intrinsic discount rate of an investment over its life.
(iii) will always give the investor the correct decision when comparing well behaved projects.

Which of the above are NOT CORRECT?

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

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15.14 An investment has the following cash inflows and cash outflows:

Time	Cash flow per annum £000
0	(20 000)
1–4	3 000
5–8	7 000
10	(10 000)

What is the net present value of the investment at a discount rate of 8%?

A (£2416)
B (£7046)
C £6981
D £2351

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15.15 An investment gives the following results:

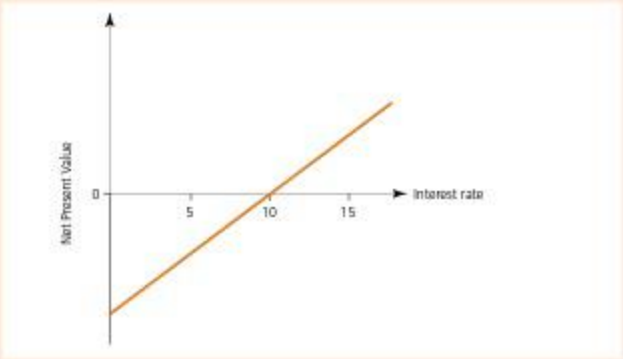
Net present value £000	Discount rate
383	10%
(246)	15%

What is the estimated internal rate of return to the nearest whole percentage?

A 12%
B 13%
C 14%
D 17%

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15.16



Which of the following is correct with regard to the above graph?

(i) The IRR is 10%.
(ii) The NPV at 15% is positive.
(iii) The project's total inflows exceed the total outflows.

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

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15.17 Mr Manaton has recently won a competition where he has the choice between receiving £5000 *now* or an annual amount forever *starting now* (i.e. a level perpetuity starting immediately). The interest rate is 8% per annum.

What would be the value of the annual perpetuity to the nearest £?

A £370
B £500
C £400
D £620

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15.18 Sydney is considering making a monthly investment for her son who will be five years old on his next birthday. She wishes to make payments until his 18th birthday and intends to pay £50 per month into an account yielding an APR of 12.68%. She plans to start making payments into the account the month after her son's fifth birthday.

How much will be in the account immediately after the final payment has been made?

A £18 847
B £18 377
C £17 606
D £18 610.

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15.19 James wants to invest his pocket money. He received £5 a month which he puts into a savings account earning compound interest at 0.5% per month.

If James saves his money, how much will be in the account in five years' time (to the nearest £)?

A £303
B £338
C £349
D £354

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15.20 Sydney wishes to make an investment on a monthly basis starting next month for five years. The payments into the fund would be made on the first day of each month.

The interest rate will be 0.5% per month. Sydney needs a terminal value of £7000.

What should be the monthly payments into the fund to the nearest £?

A £75
B £86
C £100
D £117

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15.21 Augustine wishes to take out a loan for £2000. The interest rate on this loan would be 10% per annum and Augustine wishes to make equal monthly repayments, comprising interest and principal, over three years starting one month after the loan is taken out.

What would be the monthly repayment on the loan (to the nearest £)?

A £56
B £64
C £66
D £67

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15.22 Calculations of NPV

A company has to choose between three investments with details as follows:

Investment 1		Investment 2		Investment 3	
Timing of flows Year	Cash flows per annum £	Timing of flows Year	Cash flows per annum £	Timing of flows Year	Cash flows per annum £
0	(75 000)	0	(100 000)	0	(125 000)
1–4	25 000	A perpetuity	11 000	1	30 000
5	5 000	starting at time 1		2	40 000
				3	50 000
				4	60 000
				5	(10 000)

The company has a cost of capital of 10%.

Required:

Calculate the net present value of each of the three investments at the company's cost of capital and state which investment would be preferred.

(10 marks)

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15.23 Calculation of terminal values and monthly repayments

(a) James is considering paying £50 into a fund on a monthly basis for 10 years starting in one year's time. The interest earned will be 1% per month. Once all of these payments have been made the investment will be transferred immediately to an account that will earn interest at 15% per annum until maturity. The fund matures five years after the last payment is made into the fund.

Required:

Calculate the terminal value of the fund in 15 years' time to the nearest £.

(3 marks)

15.26 Stadler is an ambitious young executive who has recently been appointed to the position of financial director of Paradis plc, a small listed company. Stadler regards this appointment as a temporary one, enabling him to gain experience before moving to a larger organization. His intention is to leave Paradis plc in three years' time, with its share price standing high. As a consequence, he is particularly concerned that the reported profits of Paradis plc should be as high as possible in his third and final year with the company.

Paradis plc has recently raised £350 000 from a rights issue, and the directors are considering three ways of using these funds. Three projects (A, B and C) are being considered, each involving the immediate purchase of equipment costing £350 000. One project only can be undertaken, and the equipment for each project will have a useful life equal to that of the project, with no scrap value. Stadler favours project C because it is expected to show the highest accounting profit in the third year. However, he does not wish to reveal his real reasons for favouring project C, and so, in his report to the chairman, he recommends project C because it shows the highest internal rate of return. The following summary is taken from his report:

Project	Net cash flows (£000) Years									Internal rate of return (%)
	0	1	2	3	4	5	6	7	8	
A	−350	100	110	104	112	138	160	180	–	27.5
B	−350	40	100	210	260	160	–	–	–	26.4
C	−350	200	150	240	40	–	–	–	–	33.0

The chairman of the company is accustomed to projects being appraised in terms of payback and accounting rate of return, and he is consequently suspicious of the use of internal rate of return as a method of project selection. Accordingly, the chairman has asked for an independent report on the choice of project. The company's cost of capital is 20% and a policy of straight-line depreciation is used to write off the cost of equipment in the financial statements.

Requirements:

(a) Calculate the payback period for each project.

(3 marks)

(b) Calculate the accounting rate of return for each project.

(5 marks)

(c) Prepare a report for the chairman with supporting calculations indicating which project should be preferred by the ordinary shareholders of Paradis plc.

(12 marks)

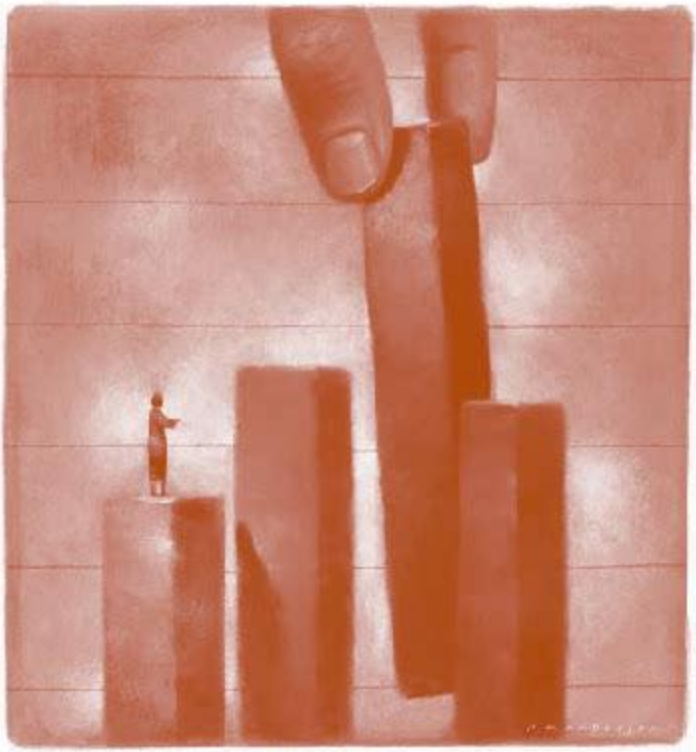
(d) Discuss the assumptions about the reactions of the stock market that are implicit in Stadler's choice of project C.

(5 marks)

Note: ignore taxation.

(Total 25 marks)

ICAEW P2 Financial Management



PART 4

Information for Planning, Control and Performance Measurement

16 The budgeting process

17 Management control systems

18 Standard costing and variance analysis

The objective in this section is to consider the implementation of decisions through the planning and control process. Planning involves systematically looking at the future, so that decisions can be made today which will bring the company its desired results. Control can be defined as the process of measuring and correcting actual performance to ensure that plans for implementing the chosen course of action are carried out.

Part Four contains three chapters. Chapter 16 considers the role of budgeting within the planning process and the relationship between the long-range plan and the budgeting process. Chapters 17 and 18 are concerned with the control process. To fully understand the role that management accounting control systems play in the control process, it is necessary to be aware of how they relate to the entire array of control mechanisms used by organizations. Chapter 17 describes the different types of controls that are used by companies. The elements of management accounting control systems are described within the context of the overall control process. Chapter 18 focuses on the technical aspects of accounting control systems. It describes the major features of a standard costing system: a system that enables the differences between the planned and actual outcomes to be analysed in detail. The operation of a standard costing system is described and the procedure for calculating the variances explained.



The budgeting process

16

In the previous seven chapters we have considered how management accounting can assist managers in making decisions. The actions that follow managerial decisions normally involve several aspects of the business, such as the marketing, production, purchasing and finance functions, and it is important that management should coordinate these various interrelated aspects of decision-making. If they fail to do this, there is a danger that managers may each make decisions that they believe are in the best interests of the organization when, in fact, taken together they are not; for example, the marketing department may introduce a promotional campaign that is designed to increase sales demand to a level beyond that which the production department can handle. The various activities within a company should be coordinated by the preparation of plans of actions for future periods. These detailed plans are usually referred to as **budgets**.

Our objective in this chapter is to focus on the planning process within a business organization and to consider the role of budgeting within this process. What do we mean by planning? Planning is the design of a desired future and of effective ways of bringing it about (Ackoff, 1981). A distinction is normally made between short-term planning (budgeting) and **long-range planning**, alternatively known as **strategic** or **corporate planning**. How is long-range planning distinguished from other forms of planning? Sizer (1989) defines long-range planning as a systematic and formalized

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- explain how budgeting fits into the overall planning and control framework;
- identify and describe the six different purposes of budgeting;
- identify and describe the various stages in the budget process;
- prepare functional and master budgets;
- describe the use of computer-based financial models for budgeting.

process for purposely directing and controlling future operations towards desired objectives for periods extending beyond one year. Short-term planning or budgeting, on the other hand, must accept the environment of today, and the physical, human and financial resources at present available to the firm. These are to a considerable extent determined by the quality of the firm's long-range planning efforts.

Relationship between budgeting and long-term planning

The annual budget should be set within the context of longer-term plans, which are likely to exist even if they have not been made explicit. Long-term planning involves strategic planning over several years and the identification of the basic strategy of the firm (i.e. the future direction the organization will take) and the gaps which exist between the future needs and present capabilities. A long-term plan is a statement of the preliminary targets and activities required by an organization to achieve its strategic plans together with a broad estimate for each year of the resources required. Because long-term planning involves 'looking into the future' for several years the plans tend to be uncertain, general in nature, imprecise and subject to change.

Budgeting is concerned with the implementation of the long-term plan for the year ahead. Because of the shorter planning horizon budgets are more precise and detailed. Budgets are a clear indication of what is expected to be achieved during the budget period whereas long-term plans represent the broad directions that top management intend to follow.

The budget is not something that originates 'from nothing' each year – it is developed within the context of ongoing business and is ruled by previous decisions that have been taken within the long-term planning process. When the activities are initially approved for inclusion in the long-term plan, they are based on uncertain estimates that are projected for several years. These proposals must be reviewed and revised in the light of more recent information. This review and revision process frequently takes place as part of the annual budgeting process, and it may result in important decisions being taken on possible activity adjustments within the current budget period. The budgeting process cannot therefore be viewed as being purely concerned with the current year – it must be considered as an integrated part of the long-term planning process.

The multiple functions of budgets

Budgets serve a number of useful purposes. They include:

1. *planning* annual operations;
2. *coordinating* the activities of the various parts of the organization and ensuring that the parts are in harmony with each other;
3. *communicating* plans to the various responsibility centre managers;
4. *motivating* managers to strive to achieve the organizational goals;
5. *controlling* activities;
6. *evaluating* the performance of managers.

Let us now examine each of these six factors.

Planning

The major planning decisions will already have been made as part of the long-term planning process. However, the annual budgeting process leads to the refinement of those plans, since managers must produce detailed plans for the implementation of the long-range plan. Without the annual budgeting process, the pressures of day-to-day operating problems may tempt managers not to plan for future operations. The budgeting process ensures that managers do plan for future operations, and that they consider how conditions in the next year might change and what steps they should take now to respond to these changed conditions. This process encourages managers to anticipate problems before they arise, and hasty decisions that are made on the spur of the moment, based on expediency rather than reasoned judgement, will be minimized.

Coordination

The budget serves as a vehicle through which the actions of the different parts of an organization can be brought together and reconciled into a common plan. Without any guidance, managers may each make their own decisions, believing that they are working in the best interests of the organization. For example, the purchasing manager may prefer to place large orders so as to obtain large discounts; the production manager will be concerned with avoiding high stock levels; and the accountant will be concerned with the impact of the decision on the cash resources of the business. It is the aim of budgeting to reconcile these differences for the good of the organization as a whole, rather than for the benefit of any individual area. Budgeting therefore compels managers to examine the relationship between their own operations and those of other departments, and, in the process, to identify and resolve conflicts.

Communication

If an organization is to function effectively, there must be definite lines of communication so that all the parts will be kept fully informed of the plans and the policies, and constraints, to which the organization is expected to conform. Everyone in the organization should have a clear understanding of the part they are expected to play in achieving the annual budget. This process will ensure that the appropriate individuals are made accountable for implementing the budget. Through the budget, top management communicates its expectations to lower level management, so that all members of the organization may understand these expectations and can coordinate their activities to attain them. It is not just the budget itself that facilitates communication – much vital information is communicated in the actual act of preparing it.

Motivation

The budget can be a useful device for influencing managerial behaviour and motivating managers to perform in line with the organizational objectives. A budget provides a standard that under certain circumstances, a manager may be motivated to strive to achieve. However, budgets can also encourage inefficiency and conflict between managers. If individuals have actively participated in preparing the budget, and it is used as a tool to assist managers in managing their departments, it can act as a strong motivational device by providing a challenge. Alternatively, if the budget is

dictated from above, and imposes a threat rather than a challenge, it may be resisted and do more harm than good.

Control

A budget assists managers in managing and controlling the activities for which they are responsible. By comparing the actual results with the budgeted amounts for different categories of expenses, managers can ascertain which costs do not conform to the original plan and thus require their attention. This process enables management to operate a system of **management by exception** which means that a manager's attention and effort can be concentrated on significant deviations from the expected results. By investigating the reasons for the deviations, managers may be able to identify inefficiencies such as the purchase of inferior quality materials. When the reasons for the inefficiencies have been found, appropriate control action should be taken to remedy the situation.

Performance evaluation

A manager's performance is often evaluated by measuring his or her success in meeting the budgets. In some companies bonuses are awarded on the basis of an employee's ability to achieve the targets specified in the periodic budgets, or promotion may be partly dependent upon a manager's budget record. In addition, the manager may wish to evaluate his or her own performance. The budget thus provides a useful means of informing managers of how well they are performing in meeting targets that they have previously helped to set.

Conflicting roles of budgets

Because a single budget system is normally used to serve several purposes there is a danger that they may conflict with each other. For instance the planning and motivation roles may be in conflict with each other. Demanding budgets that may not be achieved may be appropriate to motivate maximum performance, but they are unsuitable for planning purposes. For these a budget should be set based on easier targets that are expected to be met.

There is also a conflict between the planning and performance evaluation roles. For planning purposes budgets are set in advance of the budget period based on an anticipated set of circumstances or environment. Performance evaluation should be based on a comparison of actual performance with an adjusted budget to reflect the circumstances under which managers actually operated. In practice, many firms compare actual performance with the original budget (adjusted to the actual level of activity, i.e. a flexible budget), but if the circumstances envisaged when the original budget was set have changed then there will be a planning and evaluation conflict.

The budget period

The conventional approach is that once per year the manager of each budget centre prepares a detailed budget for one year. The budget is divided into either twelve

monthly or thirteen four-weekly periods for control purposes. The preparation of budgets on an annual basis has been strongly criticized on the grounds that it is too rigid and ties a company to a twelve month commitment, which can be risky because the budget is based on uncertain forecasts.

An alternative approach is for the annual budget to be broken down by months for the first three months, and by quarters for the remaining nine months. The quarterly budgets are then developed on a monthly basis as the year proceeds. For example, during the first quarter, the monthly budgets for the second quarter will be prepared; and during the second quarter, the monthly budgets for the third quarter will be prepared. The quarterly budgets may also be reviewed as the year unfolds. For example, during the first quarter, the budget for the next three quarters may be changed as new information becomes available. A new budget for a fifth quarter will also be prepared. This process is known as **continuous** or **rolling budgeting**, and ensures that a twelve month budget is always available by adding a quarter in the future as the quarter just ended is dropped. Contrast this with a budget prepared once per year. As the year goes by, the period for which a budget is available will shorten until the budget for next year is prepared. Rolling budgets also ensure that planning is not something that takes place once a year when the budget is being formulated. Instead, budgeting is a continuous process, and managers are encouraged to constantly look ahead and review future plans. Furthermore, it is likely that actual performance will be compared with a more realistic target, because budgets are being constantly reviewed and updated. The main disadvantage of a rolling budget is that it can create uncertainty for managers because the budget is constantly being changed.

Irrespective of whether the budget is prepared on an annual or a continuous basis, it is important that monthly or four-weekly budgets be used for *control* purposes.

Administration of the budgeting process

It is important that suitable administration procedures be introduced to ensure that the budget process works effectively. In practice, the procedures should be tailor-made to the requirements of the organization, but as a general rule a firm should ensure that procedures are established for approving the budgets and that the appropriate staff support is available for assisting managers in preparing their budgets.

The budget committee

The budget committee should consist of high-level executives who represent the major segments of the business. Its major task is to ensure that budgets are realistically established and that they are coordinated satisfactorily. The normal procedure is for the functional heads to present their budget to the committee for approval. If the budget does not reflect a reasonable level of performance, it will not be approved and the functional head will be required to adjust the budget and re-submit it for approval. It is important that the person whose performance is being measured should agree that the revised budget can be achieved; otherwise, if it is considered to be impossible to achieve, it will not act as a motivational device. If budget revisions are made, the budgetees should at least feel that they were given a fair hearing by the committee. We shall discuss budget negotiation in more detail later in this chapter.

The budget committee should appoint a budget officer, who will normally be the accountant. The role of the budget officer is to coordinate the individual budgets into a budget for the whole organization, so that the budget committee and the budgetee can see the impact of an individual budget on the organization as a whole.

Accounting staff

The accounting staff will normally assist managers in the preparation of their budgets; they will, for example, circulate and advise on the instructions about budget preparation, provide past information that may be useful for preparing the present budget, and ensure that managers submit their budgets on time. The accounting staff do not determine the content of the various budgets, but they do provide a valuable advisory and clerical service for the line managers.

Budget manual

A budget manual should be prepared by the accountant. It will describe the objectives and procedures involved in the budgeting process and will provide a useful reference source for managers responsible for budget preparation. In addition, the manual may include a timetable specifying the order in which the budgets should be prepared and the dates when they should be presented to the budget committee. The manual should be circulated to all individuals who are responsible for preparing budgets.

Stages in the budgeting process

The important stages are as follows:

1. communicating details of budget policy and guidelines to those people responsible for the preparation of budgets;
2. determining the factor that restricts output;
3. preparation of the sales budget;
4. initial preparation of various budgets;
5. negotiation of budgets with superiors;
6. coordination and review of budgets;
7. final acceptance of budgets;
8. ongoing review of budgets.

Let us now consider each of these stages in more detail.

Communicating details of the budget policy

Many decisions affecting the budget year will have been taken previously as part of the long-term planning process. The long-range plan is therefore the starting point for the preparation of the annual budget. Thus top management must communicate the policy effects of the long-term plan to those responsible for preparing the current year's budgets. Policy effects might include planned changes in sales mix, or the

expansion or contraction of certain activities. In addition, other important guidelines that are to govern the preparation of the budget should be specified – for example the allowances that are to be made for price and wage increases, and the expected changes in productivity. Also, any expected changes in industry demand and output should be communicated by top management to the managers responsible for budget preparation. It is essential that all managers be made aware of the policy of top management for implementing the long-term plan in the current year's budget so that common guidelines can be established. The process also indicates to the managers responsible for preparing the budgets how they should respond to any expected environmental changes.

Determining the factor that restricts performance

In every organization there is some factor that restricts performance for a given period. In the majority of organizations this factor is sales demand. However, it is possible for production capacity to restrict performance when sales demand is in excess of available capacity. Prior to the preparation of the budgets, it is necessary for top management to determine the factor that restricts performance, since this factor determines the point at which the annual budgeting process should begin.

Preparation of the sales budget

The volume of sales and the sales mix determine the level of a company's operations, when sales demand is the factor that restricts output. For this reason, the sales budget is the most important plan in the annual budgeting process. This budget is also the most difficult plan to produce, because total sales revenue depends on the actions of customers. In addition, sales demand may be influenced by the state of the economy or the actions of competitors.

Initial preparation of budgets

The managers who are responsible for meeting the budgeted performance should prepare the budget for those areas for which they are responsible. The preparation of the budget should be a 'bottom-up' process. This means that the budget should originate at the lowest levels of management and be refined and coordinated at higher levels. The justification for this approach is that it enables managers to participate in the preparation of their budgets and increases the probability that they will accept the budget and strive to achieve the budget targets.

There is no single way in which the appropriate quantity for a particular budget item is determined. Past data may be used as the starting point for producing the budgets, but this does not mean that budgeting is based on the assumption that what has happened in the past will occur in the future. Changes in future conditions must be taken into account, but past information may provide useful guidance for the future. In addition, managers may look to the guidelines provided by top management for determining the content of their budgets. For example, the guidelines may provide specific instructions as to the content of their budgets and the permitted changes that can be made in the prices of purchases of materials and services. For production activities standard costs may be used as the basis for costing activity volumes which are planned in the budget.

Negotiation of budgets

To implement a participative approach to budgeting, the budget should be originated at the lowest level of management. The managers at this level should submit their budget to their superiors for approval. The superior should then incorporate this budget with other budgets for which he or she is responsible and then submit this budget for approval to his or her superior. The manager who is the superior then becomes the budgetee at the next higher level. The process is illustrated in Figure 16.1. Sizer (1989) describes this approach as a two-way process of a top-down statement of objectives and strategies, bottom-up budget preparation and top-down approval by senior management.

The lower-level managers are represented by boxes 1–8. Managers 1 and 2 will prepare their budgets in accordance with the budget policy and the guidelines laid down by top management. The managers will submit their budget to their supervisor, who is in charge of the whole department (department A). Once these budgets have been agreed by the manager of department A, they will be combined by the departmental manager, who will then present this budget to his or her superior (manager of plant 1) for approval. The manager of plant 1 is also responsible for department B, and will combine the agreed budgets for departments A and B before presenting the combined budget to his or her supervisor (the production manager). The production manager will merge the budget for plants 1 and 2, and this final budget will represent the production budget that will be presented to the budget committee for approval.

At each of these stages the budgets will be negotiated between the budgetees and their superiors, and eventually they will be agreed by both parties. Hence the figures that are included in the budget are the result of a bargaining process between a manager and his or her superior. It is important that the budgetees should participate in arriving at the final budget and that the superior does not revise the budget without giving full consideration to the subordinates' arguments for including any of the budgeted items. Otherwise, real participation will not be taking place, and it is unlikely that the subordinate will be motivated to achieve a budget that he or she did not accept.

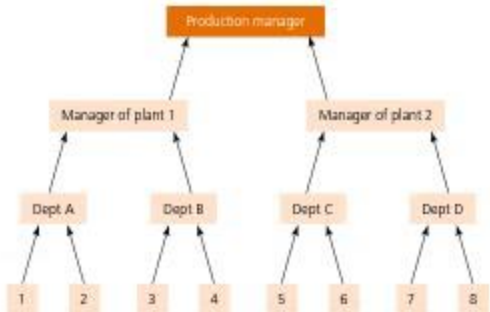
It is also necessary to be watchful that budgetees do not deliberately attempt to obtain approval for easily attainable budgets, or attempt to deliberately understate budgets in the hope that the budget that is finally agreed will represent an easily attainable target. It is equally unsatisfactory for a superior to impose difficult targets in the hope that an authoritarian approach will produce the desired results. The desired results may be achieved in the short term, but only at the cost of a loss of morale and increased labour turnover in the future.

The negotiation process is of vital importance in the budgeting process, and can determine whether the budget becomes a really effective management tool or just a clerical device. If managers are successful in establishing a position of trust and confidence with their subordinates, the negotiation process will produce a meaningful improvement in the budgetary process and outcomes for the period.

Coordination and review of budgets

As the individual budgets move up the organizational hierarchy in the negotiation process, they must be examined in relation to each other. This examination may indicate that some budgets are out of balance with other budgets and need modifying so that they will be compatible with other conditions, constraints and plans that are beyond a manager's knowledge or control. For example, a plant manager may include

FIGURE 16.1 *An illustration of budgets moving up the organization hierarchy*



equipment replacement in his or her budget when funds are simply not available. The accountant must identify such inconsistencies and bring them to the attention of the appropriate manager. Any changes in the budgets should be made by the responsible managers, and this may require that the budgets be recycled from the bottom to the top for a second or even a third time until all the budgets are coordinated and are acceptable to all the parties involved. During the coordination process, a budgeted profit and loss account, a balance sheet and a cash flow statement should be prepared to ensure that all the parts combine to produce an acceptable whole. Otherwise, further adjustments and budget recycling will be necessary until the budgeted profit and loss account, the balance sheet and the cash flow statement prove to be acceptable.

Final acceptance of the budgets

When all the budgets are in harmony with each other, they are summarized into a **master budget** consisting of a budgeted profit and loss account, a balance sheet and a cash flow statement. After the master budget has been approved, the budgets are then passed down through the organization to the appropriate responsibility centres. The approval of the master budget is the authority for the manager of each responsibility centre to carry out the plans contained in each budget.

Budget review

The budget process should not stop when the budgets have been agreed. Periodically, the actual results should be compared with the budgeted results. These comparisons should normally be made on a monthly basis and a report sent to the appropriate budgetees in the first week of the following month, so that it has the maximum motivational impact. This will enable management to identify the items that are not proceeding according to plan and to investigate the reasons for the differences. If

these differences are within the control of management, corrective action can be taken to avoid similar inefficiencies occurring again in the future. However, the differences may be due to the fact that the budget was unrealistic to begin with, or that the actual conditions during the budget year were different from those anticipated; the budget for the remainder of the year would than be invalid.

During the budget year, the budget committee should periodically evaluate the actual performance and reappraise the company's future plans. If there are any changes in the actual conditions from those originally expected, this will normally mean that the budget plans should be adjusted. This revised budget then represents a revised statement of formal operating plans for the remaining portion of the budget period. The important point to note is that the budgetary process does not end for the current year once the budget has begun; budgeting should be seen as a continuous and dynamic process.

A detailed illustration

Let us now look at an illustration of the procedure for constructing budgets in a manufacturing company, using the information contained in Example 16.1. Note that the level of detail included here is much less than that which would be presented in practice. A truly realistic illustration would fill many pages, with detailed budgets being analysed in various ways. We shall consider an annual budget, whereas a realistic illustration would analyse the annual budget into twelve monthly periods. Monthly analysis would considerably increase the size of the illustration, but would not give any further insight into the basic concepts or procedures. In addition, we shall assume in this example that the budgets are prepared for only two responsibility centres (namely departments 1 and 2). In practice, many responsibility centres are likely to exist.

Sales budget

The sales budget shows the quantities of each product that the company plans to sell and the intended selling price. It provides the predictions of total revenue from which cash receipts from customers will be estimated, and it also supplies the basic data for constructing budgets for production costs, and for selling, distribution and administrative expenses. The sales budget is therefore the foundation of all other budgets, since all expenditure is ultimately dependent on the volume of sales. If the sales budget is not accurate, the other budget estimates will be unreliable. We will assume that the Enterprise Company has completed a marketing analysis and that the following annual sales budget is based on the result:

Schedule 1 – Sales budget for year ending 200X

Product	Units sold	Selling price (£)	Total revenue (£)
Alpha	8500	400	3 400 000
Sigma	1600	560	896 000
			4 296 000

EXAMPLE 16.1

The Enterprise Company manufactures two products, known as alpha and sigma. Alpha is produced in department 1 and sigma in department 2. The following information is available for 200X.

Standard material and labour costs:

	(£)
Material X	7.20 per unit
Material Y	16.00 per unit
Direct labour	12.00 per hour

Overhead is recovered on a direct labour hour basis.

The standard material and labour usage for each product is as follows:

	Model alpha	Model sigma
Material X	10 units	8 units
Material Y	5 units	9 units
Direct labour	10 hours	15 hours

The balance sheet for the previous year end was as follows:

	(£)	(£)	(£)
Fixed assets:			
Land		170 000	
Buildings and equipment	1 292 000		
Less depreciation	255 000	1 037 000	1 207 000
Current assets:			
Stocks, finished goods	99 076		
raw materials	189 200		
Debtors	289 000		
Cash	34 000		
	611 276		
Less current liabilities			
Creditors	248 800		362 476
Net assets			1 569 476
Represented by shareholder's interest:			
1 200 000 ordinary shares of £1 each		1 200 000	
Reserves		369 476	
			1 569 476

Other relevant data is as follows for the year 200X:

	Finished product	
	Model alpha	Model sigma
Forecast sales (units)	8500	1600
Selling price per unit	£400	£560
Ending inventory required (units)	1870	90
Beginning inventory (units)	170	85

	Direct material	
	Material X	Material Y
Beginning inventory (units)	8 500	8 000
Ending inventory required (units)	10 200	1 700

	Department 1 (£)	Department 2 (£)
Budgeted variable overhead rates (per direct labour hour):		
Indirect materials	1.20	0.80
Indirect labour	1.20	1.20
Power (variable portion)	0.60	0.40
Maintenance (variable portion)	0.20	0.40
Budgeted fixed overheads		
Depreciation	100 000	80 000
Supervision	100 000	40 000
Power (fixed portion)	40 000	2 000
Maintenance (fixed portion)	45 600	3 196

	(£)
Estimated non-manufacturing overheads:	
Stationery etc. (Administration)	4 000
Salaries	
Sales	74 000
Office	28 000
Commissions	60 000
Car expenses (Sales)	22 000
Advertising	80 000
Miscellaneous (Office)	8 000
	276 000

Budgeted cash flows are as follows:

	Quarter 1 (£)	Quarter 2 (£)	Quarter 3 (£)	Quarter 4 (£)
Receipts from customers	1 000 000	1 200 000	1 120 000	985 000
Payments:				
Materials	400 000	480 000	440 000	547 984
Payments for wages	400 000	440 000	480 000	646 188
Other costs and expenses	120 000	100 000	72 016	13 642

You are required to prepare a master budget for the year 200X and the following budgets:

1 sales budget;
2 production budget;
3 direct materials usage budget;

4 direct materials purchase budget;
5 direct labour budget;
6 factory overhead budget;
7 selling and administration budget;
8 cash budget.

Schedule 1 represents the *total* sales budget for the year. In practice, the *total* sales budget will be supported by detailed *subsidiary* sales budgets where sales are analysed by areas of responsibility, such as sales territories, and into monthly periods analysed by products. The detailed *subsidiary* sales budget could be set out as shown below.

Note that with the detailed subsidiary monthly budgets the total budgeted sales of £4 296 000 is analysed by each sales territory for each month of the budget period in a similar manner to that presented for month 1. The detailed analysis assumes that sales are divided among the four sales territories as follows:

	Alpha	Sigma
North	3000 units	500 units
South	2500 units	600 units
East	1000 units	200 units
West	2000 units	300 units
	8500 units	1600 units

Detailed monthly budgets for North, South, East and West sales territories

		North		South		East		West		Total	
		Units	Value (£)	Units	Value (£)	Units	Value (£)	Units	Value (£)	Units	Value (£)
Month 1	Alpha										
	Sigma										
	Total										
Month 2											
Month 3											
Month 4											
Month 5											
Month 6											
Month 7											
Month 8											
Month 9											
Month 10											
Month 11											
Month 12											
Total months 1–12											
	Alpha	3000	1 200 000	2500	1 000 000	1000	400 000	2000	800 000	8500	3 400 000
	Sigma	500	280 000	600	336 000	200	112 000	300	168 000	1600	896 000
			1 480 000		1 336 000		512 000		968 000		4 296 000

Production budget and budgeted stock levels

When the sales budget has been completed, the next stage is to prepare the production budget. This budget is expressed in *quantities only* and is the responsibility of the production manager. The objective is to ensure that production is sufficient to meet sales demand and that economic stock levels are maintained. The production budget (schedule 2) for the year will be as follows:

Schedule 2 – Annual production budget

	Department 1 (alpha)	Department 2 (sigma)
Units to be sold	8 500	1600
Planned closing stock	1 870	90
Total units required for sales and stocks	10 370	1690
Less planned opening stocks	170	85
Units to be produced	10 200	1605

The total production for each department should also be analysed on a monthly basis.

Direct materials usage budget

The supervisors of departments 1 and 2 will prepare estimates of the materials which are required to meet the production budget. The materials usage budget for the year will be as follows:

Schedule 3 – Annual direct material usage budget

	Department 1			Department 2					
	Units	Unit price (£)	Total (£)	Units	Unit price (£)	Total (£)	Total units	Total unit price (£)	Total (£)
Material X	102 000[a]	7.20	734 400	12 840[c]	7.20	92 448	114 840	7.20	826 848
Material Y	51 000[b]	16.00	816 000	14 445[d]	16.00	231 120	65 445	16.00	1 047 120
			1 550 400			323 568			1 873 968

[a]10 200 units production at 10 units per unit of production.
[b]10 200 units production at 5 units per unit of production.
[c]1605 units production at 8 units per unit of production.
[d]1605 units production at 9 units per unit of production.

Direct materials purchase budget

The direct materials purchase budget is the responsibility of the purchasing manager, since it will be he or she who is responsible for obtaining the planned quantities of raw materials to meet the production requirements. The objective is to purchase these materials at the right time at the planned purchase price. In addition, it is necessary to take into account the planned raw material stock levels. The annual materials purchase budget for the year will be as follows:

Schedule 4 – Direct materials purchase budget

	Material X (units)	Material Y (units)
Quantity necessary to meet production requirements as per material usage budget	114 840	65 445
Planned closing stock	10 200	1 700
	125 040	67 145
Less planned opening stock	8 500	8 000
Total units to be purchased	116 540	59 145
Planned unit purchase price	£7.20	£16
Total purchases	£839 088	£946 320

Note that this budget is a summary budget for the year, but for detailed planning and control it will be necessary to analyse the annual budget on a monthly basis.

Direct labour budget

The direct labour budget is the responsibility of the respective managers of departments 1 and 2. They will prepare estimates of the departments' labour hours required to meet the planned production. Where different grades of labour exist, these should be specified separately in the budget. The budget rate per hour should be determined by the industrial relations department. The direct labour budget will be as follows:

Schedule 5 – Annual direct labour budget

	Department 1	Department 2	Total
Budgeted production (units)	10 200	1 605	
Hours per unit	10	15	
Total budgeted hours	102 000	24 075	126 075
Budgeted wage rate per hour	£12	£12	
Total wages	£1 224 000	£288 900	£1 512 900

Factory overhead budget

The factory overhead budget is also the responsibility of the respective production department managers. The total of the overhead budget will depend on the behaviour of the costs of the individual overhead items in relation to the anticipated level of production. The overheads must also be analysed according to whether they are controllable or non-controllable for the purpose of cost control. The factory overhead budget will be as follows:

Schedule 6 – Annual factory overhead budget
Anticipated activity – 102 000 direct labour hours (department 1)
24 075 direct labour hours (department 2)

	Variable overhead rate per direct labour hour		Overheads		
	Department 1 (£)	Department 2 (£)	Department 1 (£)	Department 2 (£)	Total (£)
Controllable overheads:					
Indirect material	1.20	0.80	122 400	19 260	
Indirect labour	1.20	1.20	122 400	28 890	
Power (variable portion)	0.60	0.40	61 200	9 630	
Maintenance (variable portion)	0.20	0.40	20 400	9 630	
			326 400	67 410	393 810
Non-controllable overheads:					
Depreciation			100 000	80 000	
Supervision			100 000	40 000	
Power (fixed portion)			40 000	2 000	
Maintenance (fixed portion)			45 600	3 196	
			285 600	125 196	410 796
Total overhead			612 000	192 606	804 606
Budgeted departmental overhead rate			£6.00[a]	8.00[b]	

[a] £612 000 total overheads divided by 102 000 direct labour hours.
[b] £192 606 total overheads divided by 24 075 direct labour hours.

The budgeted expenditure for the variable overhead items is determined by multiplying the budgeted direct labour hours for each department by the budgeted variable overhead rate per hour. It is assumed that all variable overheads vary in relation to direct labour hours.

Selling and administration budget

The selling and administration budgets have been combined here to simplify the presentation. In practice, separate budgets should be prepared: the sales manager will be responsible for the selling budget, the distribution manager will be responsible for the distribution expenses and the chief administrative officer will be responsible for the administration budget.

Schedule 7 – Annual selling and administration budget

	(£)	(£)
Selling:		
Salaries	74 000	
Commission	60 000	
Car expenses	22 000	
Advertising	80 000	236 000
Administration:		
Stationery	4 000	
Salaries	28 000	
Miscellaneous	8 000	40 000
		276 000

Departmental budgets

For cost control the direct labour budget, materials usage budget and factory overhead budget are combined into separate departmental budgets. These budgets are normally broken down into twelve separate monthly budgets, and the actual monthly expenditure is compared with the budgeted amounts for each of the items concerned. This comparison is used for judging how effective managers are in controlling the expenditure for which they are responsible. The departmental budget for department 1 will be as follows:

Department 1 – Annual departmental operating budget

	(£)	Budget (£)	Actual (£)
Direct labour (from schedule 5):			
102 000 hours at £12		1 224 000	
Direct materials (from schedule 3):			
102 000 units of material X at £7.20 per unit	734 400		
51 000 units of material Y at £16 per unit	816 000	1 550 400	
Controllable overheads (from schedule 6):			
Indirect materials	122 400		
Indirect labour	122 400		
Power (variable portion)	61 200		
Maintenance (variable portion)	20 400	326 400	
Uncontrollable overheads (from schedule 6):			
Depreciation	100 000		
Supervision	100 000		
Power (fixed portion)	40 000		
Maintenance (fixed portion)	45 600	285 600	
		3 386 400	

Master budget

When all the budgets have been prepared, the budgeted profit and loss account and balance sheet provide the overall picture of the planned performance for the budget period.

Budgeted profit and loss account for the year ending 200X

	(£)	(£)
Sales (schedule 1)		4 296 000
Opening stock of raw materials (from opening balance sheet)	189 200	
Purchases (schedule 4)	1 785 408[a]	
	1 974 608	
Less closing stock of raw materials (schedule 4)	100 640[b]	
Cost of raw materials consumed	1 873 968	
Direct labour (schedule 5)	1 512 900	
Factory overheads (schedule 6)	804 606	
Total manufacturing cost	4 191 474	
Add opening stock of finished goods (from opening balance sheet)	99 076	
Less closing stock of finished goods	665 984[c]	
	(566 908)	
Cost of sales		3 624 566
Gross profit		671 434
Selling and administration expenses (schedule 7)		276 000
Budgeted operating profit for the year		395 434

[a] £839 088 (X) + £946 320 (Y) from schedule 4.
[b] 10 200 units at £7.20 plus 1700 units at £16 from schedule 4.
[c] 1870 units of alpha valued at £332 per unit, 90 units of sigma valued at £501.60 per unit. The product unit costs are calculated as follows:

	Alpha		Sigma	
	Units	(£)	Units	(£)
Direct materials				
X	10	72.00	8	57.60
Y	5	80.00	9	144.00
Direct labour	10	120.00	15	180.00
Factory overheads:				
Department 1	10	60.00	—	—
Department 2	—	—	15	120.00
		332.00		501.60

Budgeted balance sheet as at 31 December

	(£)	(£)
Fixed assets:		
Land		170 000
Building and equipment	1 292 000	
Less depreciation[a]	435 000	857 000
		1 027 000
Current assets:		
Raw material stock	100 640	
Finished good stock	665 984	
Debtors[b]	280 000	
Cash[c]	199 170	
	1 245 794	
Current liabilities:		
Creditors[d]	307 884	937 910
		1 964 910
Represented by shareholders' interest:		
1 200 000 ordinary shares of £1 each	1 200 000	
Reserves	369 476	
Profit and loss account	395 434	1 964 910

[a] £255 000 + £180 000 (schedule 6) = £435 000.
[b] £289 000 opening balance + £4 296 000 sales – £4 305 000 cash.
[c] Closing balance as per cash budget.
[d] £248 800 opening balance + £1 785 408 purchases + £141 660 indirect materials – £1 876 984 cash.

Cash budgets

The objective of the **cash budget** is to ensure that sufficient cash is available at all times to meet the level of operations that are outlined in the various budgets. The cash budget for Example 16.1 is presented below and is analysed by quarters, but in practice monthly or weekly budgets will be necessary. Because cash budgeting is subject to uncertainty, it is necessary to provide for more than the minimum amount required, to allow for some margin of error in planning. Cash budgets can help a firm to avoid cash balances that are surplus to its requirements by enabling management to take steps in advance to invest the surplus cash in short-term investments. Alternatively, cash deficiencies can be identified in advance, and steps can be taken to ensure that bank loans will be available to meet any temporary cash deficiencies. For example, by looking at the cash budget for the Enterprise Company, management may consider that the cash balances are higher than necessary in the second and third quarters of the year, and they may invest part of the cash balance in short-term investments.

The overall aim should be to manage the cash of the firm to attain maximum cash availability and maximum interest income on any idle funds.

Cash budget for year ending 200X

	Quarter 1 (£)	Quarter 2 (£)	Quarter 3 (£)	Quarter 4 (£)	Total (£)
Opening balance	34 000	114 000	294 000	421 984	34 000
Receipts from debtors	1 000 000	1 200 000	1 120 000	985 000	4 305 000
	1 034 000	1 314 000	1 414 000	1 406 984	4 339 000
Payments:					
Purchase of materials	400 000	480 000	440 000	547 984	1 867 984
Payment of wages	400 000	440 000	480 000	646 188	1 966 188
Other costs and expenses	120 000	100 000	72 016	13 642	305 658
	920 000	1 020 000	992 016	1 207 814	4 139 830
Closing balance	114 000	294 000	421 984	199 170	199 170

Final review

The budgeted profit and loss account, the balance sheet and the cash budget will be submitted by the accountant to the budget committee, together with a number of budgeted financial ratios such as the return on capital employed, working capital, liquidity and gearing ratios. If these ratios prove to be acceptable, the budgets will be approved. In Example 16.1 the return on capital employed is approximately 20%, but the working capital ratio (current assets:current liabilities) is over 4:1, so management should consider alternative ways of reducing investment in working capital before finally approving the budgets.

Computerized budgeting

In the past, budgeting was a task dreaded by many management accountants. You will have noted from Example 16.1 that many numerical manipulations are necessary to prepare the budget. In the real world the process is far more complex, and, as the budget is being formulated, it is altered many times since some budgets are found to be out of balance with each other or the master budget proves to be unacceptable.

In today's world, the budgeting process is computerized and instead of being primarily concerned with numerical manipulations, the accounting staff can now become more involved in the real planning process. Computer-based financial models normally consist of mathematical statements of inputs and outputs. By simply altering the mathematical statements budgets can be quickly revised with little effort. However, the major advantage of computerized budgeting is that management can evaluate many different options before the budget is finally agreed. Establishing a model enables 'What-if?' analysis to be employed. For example, answers to the following questions can be displayed in the form of a master budget: What if sales increase or decrease by 10%? What if unit costs increase or decrease by 5%? What if the credit terms for sales were reduced from 30 to 20 days?

In addition, computerized models can incorporate actual results, period by period, and carry out the necessary calculations to produce budgetary *control* reports. It is also possible to adjust the budgets for the remainder of the year when it is clear that the circumstances on which the budget was originally set have changed.



Using Web technology for the budget process

An e-budgeting solution completely automates the development of an organization's budget and forecast. From anywhere in the world, at all times, participants in the process can log through the Internet to access their budget and any pertinent related information so they can work on their plans. Web-based enterprise budgeting systems offer a centrally administered system that provides easy-to-use flexible tools for the end users who are responsible for budgeting. The Web functionality of these applications allows constant monitoring, updates and modelling.

E-budgeting provides the flexibility demanded by modern organizations. For example, the finance department can request across-the-board reallocations of expenditures and model the result immediately. No longer do management accountants have to go back and forth with other managers reinputting data and retallying results. E-budgeting can eliminate the cumbersome accounting tasks of pulling numbers from disparate files, cutting and pasting, entering and uploading, and constantly performing reconciliation. Also, a Web-based budgeting application lets managers access data from office or home – wherever they happen to be working. It broadens the system's availability to the user community.

When executives at Toronto-Dominion Bank were searching for a new solution capable of handling the bank's enterprise budgeting and planning function, they turned to the Internet. The company selected Clarus Corporation's Web-deployed, enterprise Clarus™ Budget solution. Its accountant stated 'in the past, we have compiled our business plan using hundreds of spreadsheets, and our analysts have spent a disproportionate amount of their time compiling and verifying data from multiple sources. Implementing a Web-based, enterprise-wide budgeting solution will help us to develop our business plans and allow our analysts to be proactive in monitoring quarterly results.'

Source: Adapted from Hornyak, S. (2000), Budgeting made easy, in Reeve, J.M. (ed.), *Readings and Issues in Cost Management*, South Western College Publishing, pp. 341–6.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain how budgeting fits into the overall planning and control framework.**

  The annual budget should be set within the context of longer-term plans, which are likely to exist even if they have not been made explicit. A long-term plan is a statement of the preliminary targets and activities required by an organization to achieve its strategic plans together with a broad estimate for each year of the resources required. Because long-term planning involves 'looking into the future' for several years, the plans tend to be uncertain, general in nature, imprecise and subject to change. Annual budgeting is concerned with the detailed implementation of the long-term plan for the year ahead. As the year progresses the control process involves comparing planned and actual outcomes and responding to any deviations by taking appropriate remedial action to ensure that future results will conform to the annual budget. Alternatively, the annual budget may have to be changed if

remedial action cannot be taken. Budgeting is therefore a continuous and dynamic process, and should not end once the annual budget has been prepared.

- **Identify and describe the six different purposes of budgeting.**

  Budgets are used for the following purposes: (a) planning annual operations; (b) coordinating the activities of the various parts of the organization and ensuring that the parts are in harmony with each other; (c) communicating the plans to the managers of the various responsibility centres; (d) motivating managers to strive to achieve organizational goals; (e) controlling activities; and (f) evaluating the performance of managers.

- **Identify and describe the various stages in the budget process.**

  The important stages are as follows: (a) communicating details of the budget policy and guidelines to those people responsible for the preparation of the budgets; (b) determining the factor that restricts output (normally sales volume); (c) preparation of the sales budget (assuming that sales demand is the factor that restricts output); (d) initial preparation of the various budgets; (e) negotiation of budgets with superiors; (f) coordination and review of budgets; (g) final acceptance of budgets; and (h) ongoing review of budgets. Each of the above stages is described in the chapter.

- **Prepare functional and master budgets.**

  When all of the budgets have been prepared they are summarized into a master budget consisting in a budgeted profit and loss account, a balance sheet and a cash budget statement. The preparation of functional and master budgets was illustrated using Example 16.1.

- **Describe the use of computer-based financial models for budgeting.**

  Computer-based financial models are mathematical statements of the inputs and output relationships that affect the budget. These models allow management to conduct sensitivity analysis to ascertain the effects on the master budget of changes in the original predicted data or changes in the assumptions that were used to prepare the budgets.



Key terms and concepts

budgeting (p. 426)
budgets (p. 425)
cash budgets (p. 443)
continuous budgeting (p. 429)
corporate planning (p. 425)
long-range planning (p. 425)
management by exception (p. 428)
master budget (p. 433)
rolling budgeting (p. 429)
strategic planning (p. 425)

Key examination points

Examination questions on budgeting frequently require the preparation of functional or cash budgets. A common mistake is to incorrectly deduct closing stocks and add opening stocks when preparing production and material purchase budgets (see Review problems 16.10, 16.12 and 16.15).



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. Cases that are relevant to the content of this chapter include Endeavour Twoplise Ltd and Global Ltd.

Review questions

16.1 Define the term 'budget'. How are budgets used in planning? (*pp. 425–6*)

16.2 Distinguish between budgeting and long-range planning. How are they related? (*p. 426*)

16.3 Describe the different purposes of budgeting. (*pp. 426–8*)

16.4 Explain what is meant by the term 'management by exception'. (*p. 428*)

16.5 Describe how the different roles of budgets can conflict with each other. (*p. 428*)

16.6 Distinguish between continuous and rolling budgets. (*p. 429*)

16.7 Describe the different stages in the budgeting process. (*pp. 430–3*)

16.8 All budgets depend on the sales budget. Do you agree? Explain. *(pp. 430–1)*

16.9 What is a master budget? *(p. 433)*

Review problems

16.10 When preparing a production budget, the quantity to be produced equals

A sales quantity + opening stock + closing stock
B sales quantity – opening stock + closing stock
C sales quantity – opening stock – closing stock
D sales quantity + opening stock – closing stock
E sales quantity

CIMA Stage 2

16.11 BDL plc is current preparing its cash budget for the year to 31 March 2003. An extract from its sales budget for the same year shows the following sales values:

	£
March	60 000
April	70 000
May	55 000
June	65 000

40% of its sales are expected to be for cash. Of its credit sales, 70% are expected to pay in the month after sale and take a 2% discount; 27% are expected to pay in the second month after the sale, and the remaining 3% are expected to be bad debts.

The value of sales receipts to be shown in the cash budget for May 2002 is:

A £38 532
B £39 120
C £60 532
D £64 220
E £65 200

CIMA Stage 2

16.12 A company is preparing a production budget for the next year. The following information is relevant:

Budgeted sales	10 000 units
Opening stock	600 units
Closing stock	5% of budgeted sales

The production process is such that 10% of the units produced are rejected.

What is the number of units required to be produced to meet demand?

A 8900 units
B 9900 units
C 10 900 units
D 11 000 units

16.13 Which of the following is the responsibility of the budget committee?

A Taking corrective action to ensure that sales targets are achieved.
B Ensuring the sales budget is consistent with other budgets.
C Providing information on sales levels and prices in previous budget periods.
D Drawing up the sales budget.

CIMA – Management AccountingFundamentals

16.14 The benefits of using a computerized budget system as opposed to a manual one are:

(i) data used in drawing up the budget can be processed more quickly;
(ii) budget targets will be more acceptable to the managers responsible for their achievement;
(iii) changes in variables can be incorporated into the budget more quickly;
(iv) the principal budget factor can be identified before budget preparation begins;
(v) continuous budgeting is only possible using a computerized system.

A (i) and (iii) only
B (i), (ii) and (iii) only
C (i), (iii) and (iv) only
D (i), (iii) and (v) only

CIMA – Management Accounting Fundamentals

16.15 A company has the following budget for the next month:

Finished Product	
Sales	7000 units
Production units	7200 units
Materials	
Usage per unit	3 kg
Opening stock	400 kg
Closing stock	500 kg

What is the material purchases budget for the month?

A 20 900 kg
B 21 100 kg
C 21 500 kg
D 21 700 kg

ACCA Paper 1.2 – Financial Information for Management

16.16 The following estimates have been prepared for a retailer's next budget period:

	$
Sales	160 000
Opening debtors	27 500
Closing debtors	19 400
Opening stock	16 600
Closing stock	18 700

The gross profit margin on sales is budgeted at 55%.

(a) The cash which the retailer expects to receive from customers during the budget period amounts to

(i) $88 000
(ii) $151 900
(iii) $157 900
(iv) $168 100

(b) The value of purchases made by the retailer during the budget period is expected to be

(i) $69 900
(ii) $74 100
(iii) $85 900
(iv) $90 100

CIMA – Management Accounting Fundamentals

16.17 Preparation of functional budgets, cash budget and master budget

The budgeted balance sheet data of Kwan Tong Umbago Ltd is as follows:

	1 March		
	Cost (£)	Depreciation to date (£)	Net (£)
Fixed assets			
Land and buildings	500 000	—	500 000
Machinery and equipment	124 000	84 500	39 500
Motor vehicles	42 000	16 400	25 600
	666 000	100 900	565 100
Working capital:			
Current assets			
Stock of raw materials (100 units)		4 320	
Stock of finished goods (110 units)[a]		10 450	
Debtors (January £7680 February £10 400)		18 080	
Cash and bank		6 790	
		39 640	
Less current liabilities			
Creditors (raw materials)		3 900	35 740
			600 840
Represented by:			
Ordinary share capital (fully paid) £1 shares			500 000
Share premium			60 000
Profit and loss account			40 840
			600 840

[a]The stock of finished goods was valued at marginal cost

The estimates for the next four-month period are as follows:

	March	April	May	June
Sales (units)	80	84	96	94
Production (units)	70	75	90	90
Purchases of raw materials (units)	80	80	85	85
Wages and variable overheads at £65 per unit	£4550	£4875	£5850	£5850
Fixed overheads	£1200	£1200	£1200	£1200

The company intends to sell each unit for £219 and has estimated that it will have to pay £45 per unit for raw materials. One unit of raw material is needed for each unit of finished product.

All sales and purchases of raw materials are on credit. Debtors are allowed two months' credit and suppliers of raw materials are paid after one month's credit. The wages, variable overheads and fixed overheads are paid in the month in which they are incurred.

Cash from a loan secured on the land and buildings of £120 000 at an interest rate of 7.5% is due to be received on 1 May. Machinery costing £112 000 will be received in May and paid for in June.

The loan interest is payable half yearly from September onwards. An interim dividend to 31 March of £12 500 will be paid in June.

Depreciation for the four months, including that on the new machinery is:

Machinery and equipment	£15 733
Motor vehicles	£3 500

The company uses the FIFO method of stock valuation. Ignore taxation.

Required:

(a) Calculate and present the raw materials budget and finished goods budget in terms of units, for each month from March to June inclusive.
(5 marks)

(b) Calculate the corresponding sales budgets, the production cost budgets and the budgeted closing debtors, creditors and stocks in terms of value.
(5 marks)

(c) Prepare and present a cash budget for each of the four months.
(6 marks)

(d) Prepare a master budget, i.e. a budgeted trading and profit and loss account, for the four months to 30 June, and budgeted balance sheet as at 30 June.
(10 marks)

(e) Advise the company about possible ways in which it can improve its cash management.
(9 marks)

(Total 35 marks)

ACCA Paper 8 Managerial Finance

16.18 Budget preparation and comments on sales forecasting methods

You have recently been appointed as the management accountant to Alderley Ltd, a small company manufacturing two products, the Elgar and the Holst. Both products use the same type of material and labour but in different proportions. In the past, the company has had poor control over its working capital. To remedy this, you have recommended to the directors that a budgetary control system be introduced. This proposal has, now, been agreed.

Because Alderley Ltd's production and sales are spread evenly over the year, it was agreed that the annual budget should be broken down into four periods, each of 13 weeks, and commencing with the 13 weeks ending 4 April. To help you in this task, the sales and production directors have provided you with the following information:

1. Marketing and production data

	Elgar	Holst
Budgeted sales for 13 weeks (units)	845	1235
Material content per unit (kilograms)	7	8
Labour per unit (standard hours)	8	5

2. Production labour
   The 24 production employees work a 37-hour, five-day week and are paid £8 per hour. Any hours in excess of this involve Alderley in paying an overtime premium of 25%. Because of technical problems, which will continue over the next 13 weeks, employees are only able to work at 95% efficiency compared to standard.
3. Purchasing and opening stocks
   The production director believes that raw material will cost £12 per kilogram over the budget period. He also plans to revise the amount of stock being kept. He estimates that the stock levels at the commencement of the budget period will be as follows:

Raw materials	Elgar	Holst
2328 kilograms	163 units	361 units

4. Closing stocks
   At the end of the 13-week period closing stocks are planned to change. On the assumption that production and sales volumes for the second budget period will be similar to those in the first period:
   - raw material stocks should be sufficient for 13 days' production;
   - finished stocks of the Elgar should be equivalent to 6 days' sales volume;
   - finished stocks of the Holst should be equivalent to 14 days' sales volume.

Task 1

Prepare in the form of a statement the following information for the 13-week period to 4 April:

(a) the production budget in units for the Elgar and Holst;

(b) the purchasing budget for Alderley Ltd in units;

(c) the cost of purchases for the period;

(d) the production labour budget for Alderley Ltd in hours;

(e) the cost of production labour for the period.

Note: Assume a five-day week for both sales and production.

The managing director of Alderley Ltd, Alan Dunn, has also only recently been appointed. He is keen to develop the company and has already agreed to two new products being developed. These will be launched in 18 months' time. While talking to you about the budget, he mentions that the quality of sales forecasting will need to improve if the company is to grow rapidly. Currently, the budgeted sales figure is found by initially adding 5% to the previous year's sales volume and then revising the figure following discussions with the marketing director. He believes this approach is increasingly inadequate and now requires a more systematic approach.

A few days later, Alan Dunn sends you a memo. In that memo, he identifies three possible strategies for increasing sales volume. They are:

- more sales to existing customers;
- the development of new markets;
- the development of new products.

He asks for your help in forecasting likely sales volumes from these sources.

Task 2

Write a brief memo to Alan Dunn. Your memo should:

(a) identify *four* ways of forecasting future sales volume;

(b) show how each of your four ways of forecasting can be applied to *one* of the sales strategies identified by Alan Dunn and justify your choice;

(c) give *two* reasons why forecasting methods might not prove to be accurate.

AAT Technicians Stage

16.19 Preparation of cash budgets

The management of Beck plc have been informed that the union representing the direct production workers at one of their factories, where a standard product is produced, intends to call a strike. The accountant has been asked to advise the management of the effect the strike will have on cash flow.

The following data has been made available:

	Week 1	Week 2	Week 3
Budgeted sales	400 units	500 units	400 units
Budgeted production	600 units	400 units	Nil

The strike will commence at the beginning of week 3 and it should be assumed that it will continue for at least four weeks. Sales at 400 units per week will continue to be made during the period of the strike until stocks of

finished goods are exhausted. Production will stop at the end of week 2. The current stock level of finished goods is 600 units. Stocks of work in progress are not carried.

The selling price of the product is £60 and the budgeted manufacturing cost is made up as follows:

	(£)
Direct materials	15
Direct wages	7
Variable overheads	8
Fixed overheads	18
Total	£48

Direct wages are regarded as a variable cost. The company operates a full absorption costing system and the fixed overhead absorption rate is based upon a budgeted fixed overhead of £9000 per week. Included in the total fixed overheads is £700 per week for depreciation of equipment. During the period of the strike direct wages and variable overheads would not be incurred and the cash expended on fixed overheads would be reduced by £1500 per week.

The current stock of raw materials are worth £7500; it is intended that these stocks should increase to £11 000 by the end of week 1 and then remain at this level during the period of the strike. *All direct materials are paid for one week after they have been received. Direct wages are paid one week in arrears. It should be assumed that all relevant overheads are paid for immediately the expense is incurred.* All sales are on credit, 70% of the sales value is received in cash from the debtors at the end of the first week after the sales have been made and the balance at the end of the second week.

The current amount outstanding to material suppliers is £8000 and direct wage accruals amount to £3200. Both of these will be paid in week 1. The current balance owing from debtors is £31 200, of which £24 000 will be received during week 1 and the remainder during week 2. The current balance of cash at bank and in hand is £1000.

Required:

(a) (i) Prepare a cash budget for weeks 1 to 6 showing the balance of cash at the end of each week together with a suitable analysis of the receipts and payments during each week.

(13 marks)

(ii) Comment upon any matters arising from the cash budget which you consider should be brought to management's attention.

(4 marks)

(b) Explain why the reported profit figure for a period does not normally represent the amount of cash generated in that period.

(5 marks)

(Total 22 marks)

ACCA Level 1 Costing



Management control systems

17

Control is the process of ensuring that a firm's activities conform to its plan and that its objectives are achieved. There can be no control without objectives and plans, since these predetermine and specify the desirable behaviour and set out the procedures that should be followed by members of the organization to ensure that a firm is operated in a desired manner.

Drucker (1964) distinguishes between 'controls' and 'control'. **Controls** are measurement and information, whereas control means direction. In other words, 'controls' are purely a means to an end; the end is control. **'Control'** is the function that makes sure that actual work is done to fulfil the original intention, and 'controls' are used to provide information to assist in determining the control action to be taken. For example, material costs may be greater than budget. 'Controls' will indicate that costs

LEARNING OBJECTIVES:

After studying this chapter you should be able to:

- describe the three different types of controls used in organizations;
- describe a cybernetic control system;
- distinguish between feedback and feed-forward controls;
- define the four different types of responsibility centres;
- explain the different elements of management accounting control systems;
- describe the controllability principle and the methods of implementing it;
- describe the different approaches that can be used to determine financial performance targets and discuss the impact of their level of difficulty on motivation and performance;
- describe the influence of participation in the budgeting process;
- explain why a performance measurement system should also emphasize non-financial measures;
- describe activity-based cost management.

exceed budget and that this may be because the purchase of inferior quality materials causes excessive wastage. 'Control' is the action that is taken to purchase the correct quality materials in the future to reduce excessive wastage.

'Controls' encompasses all the methods and procedures that direct employees towards achieving the organization objectives. Many different control mechanisms are used in organizations and the management accounting control system represents only one aspect of the various control mechanisms that companies use to control their managers and employees. To fully understand the role that management accounting control systems play in the control process, it is necessary to be aware of how they relate to the entire array of control mechanisms used by organizations.

This chapter begins by describing the different types of controls that are used by companies. The elements of management accounting control systems will then be described within the context of the overall control process.

Different types of controls

Companies use many different control mechanisms to cope with the problem of organizational control. To make sense of the vast number of controls that are used we shall classify them into three categories using approaches that have been adopted by Ouchi (1979) and Merchant (1998). They are:

1. action (or behavioural) controls;
2. personnel and cultural (or clan and social) controls;
3. results (or output) controls.

The terms in parentheses refer to the classification used by Ouchi whereas the other terms refer to the categories specified by Merchant. Because the classifications used by both authors are compatible we shall use the terms interchangeably. You should note that management accounting systems are normally synonymous with output controls whereas management control systems encompass all of the above categories of controls.

Action or behavioural controls

Behavioural controls involve observing the actions of individuals as they go about their work. They are appropriate where cause and effect relationships are well understood, so that if the correct means are followed, the desired outcomes will occur. Under these circumstances effective control can be achieved by having superiors watch and guide the actions of subordinates. For example, if the foreman watches the workers on the assembly line and ensures that the work is done exactly as prescribed then the expected quality and quantity of work should ensue.

Instead of using the term behavioural controls Merchant uses the term action controls. He defines **action controls** as applying to those situations where the actions themselves are the focus of control. They are usable and effective only when managers know what actions are desirable (or undesirable) and have the ability to make sure that the desirable actions occur (or that the undesirable actions do not occur). Forms of action controls described by Merchant include behavioural constraints, preaction reviews and action accountability.

The aim of *behavioural constraints* is to prevent people from doing things that should not be done. They include physical constraints, such as computer passwords

that restrict accessing or updating information sources to authorized personnel, and administrative constraints. Imposing ceilings on the amount of capital expenditure that managers may authorize is an example of an administrative constraint. For example, managers at lower levels may be able to authorize capital expenditure below £10 000 within a total annual budget of, say, £100 000. The aim is to ensure that only those personnel with the necessary expertise and authority can authorize major expenditure and that such expenditure remains under their control.

Preaction reviews involve the scrutiny and approval of action plans of the individuals being controlled before they can undertake a course of action. Examples include the approval by municipal authorities of plans for the construction of properties prior to building commencing or the approval by a tutor of a dissertation plan prior to the student being authorized to embark on the dissertation.

Action accountability involves defining actions that are acceptable or unacceptable, observing the actions and rewarding acceptable or punishing unacceptable actions. Examples of action accountability include establishing work rules and procedures and company codes of conduct that employees must follow.

Action controls that focus on *preventing* undesirable behaviour are the ideal form of control because their aim is to prevent the behaviour from occurring. They are preferable to *detection* controls that are applied after the occurrence of the actions because they avoid the costs of undesirable behaviour. Nevertheless, detection controls can still be useful if they are applied in a timely manner so that they can lead to the early cessation of undesirable actions. Their existence also discourages individuals from engaging in such actions.

Personnel, cultural and social controls

Clan and social controls are the second types of controls described by Ouchi. **Clan controls** are based on the belief that by fostering a strong sense of solidarity and commitment towards organizational goals people can become immersed in the interests of the organization. The main feature of clan controls is the high degree of employee discipline attained through the dedication of each individual to the interests of the whole. At a less extreme level clan controls can be viewed as corporate cultures or a special form of **social control** such as the selection of people who have already been socialized into adopting particular norms and patterns of behaviour to perform particular tasks. For example, if the only staff promoted to managerial level are those who display a high commitment to the firm's objectives then the need for other forms of controls can be reduced, provided that the managers are committed to achieving the 'right' objectives.

Merchant adopts a similar approach to Ouchi and classifies personnel and cultural controls as a second form of control. He defines **personnel controls** as helping employees do a good job by building on employees' natural tendencies to control themselves. In particular, they ensure that the employees have the capabilities (in terms of intelligence, qualifications and experience) and the resources needed to do a good job. Merchant identifies three major methods of implementing personnel controls. They are selection and placement, training and job design and the provision of the necessary resources. Selection and placement involves finding the right people to do a specified job. Training can be used to ensure that employees know how to perform the assigned tasks and to make them fully aware of the results and actions that are expected from them. Job design entails designing jobs in such a way that employees are able to undertake their tasks with a high degree of success. This requires that jobs are not made too complex, onerous or badly defined so that employees do not know what is expected of them.

Cultural controls represent a set of values, social norms and beliefs that are shared by members of the organization and that influence their actions. Cultural controls are exercised by individuals over one another – for example, procedures used by groups within an organization to regulate performance of their own members and to bring them into line when they deviate from group norms. It is apparent from the above description that cultural controls are virtually the same as social controls.

Results or output controls

Output or **results controls** involve collecting and reporting information about the outcomes of work effort. The major advantage of results controls is that senior managers do not have to be knowledgeable about the means required to achieve the desired results or be involved in directly observing the actions of subordinates. They merely rely on output reports to ascertain whether or not the desired outcomes have been achieved. Management accounting control systems can be described as a form of output controls. They are mostly defined in monetary terms such as revenues, costs, profits and ratios such as return on investment. Results measures also include non-accounting measures such as the number of units of defective production, the number of loan applications processed or ratio measures such as the number of customer deliveries on time as a percentage of total deliveries.

Results controls involve the following stages:

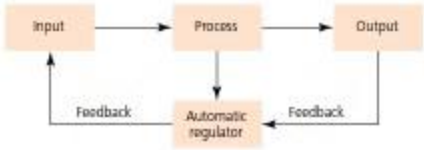
1. establishing results (i.e. performance) measures that minimize undesirable behaviour;
2. establishing performance targets;
3. measuring performance;
4. providing rewards or punishment.

Ideally desirable behaviour should improve the performance measure and undesirable behaviour should have a detrimental effect on the measure. Without the *second-stage* requirement of a pre-set performance target individuals do not know what to aim for. Various research studies suggest that the existence of a clearly defined quantitative target is likely to motivate higher performance than vague statements such as 'do your best'. It is also difficult for employees or their superiors to interpret performance unless actual performance can be compared against predetermined standards.

The *third stage* specified above relates to measuring performance. Ability to measure some outputs effectively constrains the use of results measures. For example, it can be extremely difficult to measure the outputs of support departments. Consider a personnel department. The accomplishments of the department can be difficult to measure and other forms of control might be preferable. Merchant suggests that to evoke the right behaviours results measures should be precise, objective, timely and understandable.

Whilst 100% accuracy is not essential, measurements should be sufficiently accurate for the purpose required. If measures are not sufficiently precise they will have little information value and may lead to managers misevaluating performance. Measures should also be objective and free from bias. Where performance is self-measured and reported there is a danger that measures will be biased. Objectivity can be increased by performance being measured by people who are independent of the process being measured. Timeliness relates to the time lag between actual performance and the

FIGURE 17.1 *A cybernetic control system*



reporting of the results. Significant delays in reporting will result in the measures losing most of their motivational impact and a lengthy delay in taking remedial action when outcomes deviate from target. Finally, measures should be understandable by the individuals whose behaviours are being controlled. If measures are not understandable it is unlikely that managers will know how their actions will effect the measure and there is a danger that the measures will lose their motivational impact.

The *final stage* of results controls involves encouraging employees to achieve organizational goals by having rewards (or punishments) linked to their success (or failure) in achieving the results measures. Organizational rewards include salary increases, bonuses, promotions and recognition. Employees can also derive intrinsic rewards through a sense of accomplishment and achievement. Punishments include demotions, failure to obtain the rewards and possibly the loss of one's job.

Cybernetic control systems

The traditional approach in the management control literature has been to view results controls as a simple **cybernetic system**. In describing this process authors often use a mechanical model such as a thermostat that controls a central heating system as a resemblance. This process is illustrated in Figure 17.1. You will see that the control system consists of the following elements:

1. The process (the room's temperature) is continually monitored by an automatic regulator (the thermostat).
2. Deviations from a predetermined level (the desired temperature) are identified by the automatic regulator.
3. Corrective actions are started if the output is not equal to the predetermined level. The automatic regulator causes the input to be adjusted by turning the heater on if the temperature falls below a predetermined level. The heater is turned off when the output (temperature) corresponds with the predetermined level.

The output of the process is monitored, and whenever it varies from the predetermined level, the input is automatically adjusted. Emmanuel *et al.* (1990) state that four conditions must be satisfied before any process can be said to be controlled. First, objectives for the process being controlled must exist. Without an aim or purpose control has no meaning. Secondly, the output of the process must be measurable in terms of the dimensions defined by the objectives. In other words, there must be some mechanism for ascertaining whether the process is attaining its objectives. Thirdly, a

predictive model of the process being controlled is required so that causes for the non-attainment can be identified and proposed corrective actions evaluated. Finally, there must be a capability for taking action so that deviations from objectives can be reduced. Emmanuel *et al.* stress that if any of these conditions are not met the process cannot be considered to be 'in control'.

Result controls and therefore management accounting controls resemble the thermostat control model. Standards of performance are determined, measurement systems monitor performance, comparisons are made between the standard and actual performance and feedback provides information on the variances. Note that the term **variance** is used to describe the difference the standard and actual performance of the actions that are being measured.

Feedback and feed-forward controls

The cybernetic system of control described in Figure 17.1 is that of feedback control. **Feedback control** involves monitoring outputs achieved against desired outputs and taking whatever corrective action is necessary if a deviation exists. In **feed-forward control** instead of actual outputs being compared against desired outputs, predictions are made of what outputs are expected to be at some future time. If these expectations differ from what is desired, control actions are taken that will minimize these differences. The objective is for control to be achieved before any deviations from desired outputs actually occur. In other words, with feed-forward controls likely errors can be anticipated and steps taken to avoid them, whereas with feedback controls actual errors are identified after the event and corrective action is taken to implement future actions to achieve the desired outputs.

Feed-forward control requires the use of a predictive model that is sufficiently accurate to ensure that control action will improve the situation and not cause it to deteriorate further. A major limitation of feedback control is that errors are allowed to occur. This is not a significant problem when there is a short time lag between the occurrence of an error and the identification and implementation of corrective action. Feed-forward control is therefore preferable when a significant time lag occurs. The budgeting process is a feed-forward control system. To the extent that outcomes fall short of what is desired, alternatives are considered until a budget is produced that is expected to achieve what is desired. The comparison of actual results with budget, in identifying variances and taking remedial action to ensure that future outcomes will conform with budgeted outcomes is an illustration of a feedback control system. Thus accounting control systems consist of both feedback and feed-forward controls.

Management accounting control systems

Although output controls predominantly consist of management accounting controls the latter have not been examined in detail. To enable you to understand the role that management accounting control systems play within the overall control process this chapter has initially adopted a broad approach to describing management control systems. We shall now concentrate on management accounting control systems which represent the predominant controls in most organizations.

Why are accounting controls the predominant controls? There are several reasons. First, all organizations need to express and aggregate the results of a wide range of dissimilar activities using a common measure. The monetary measure meets this

requirement. Second, profitability and liquidity are essential to the success of all organizations and financial measures relating to these and other areas are closely monitored by stakeholders. It is therefore natural that managers will wish to monitor performance in monetary terms. Third, financial measures also enable a common decision rule to be applied by all managers when considering alternative courses of action. That is, a course of action will normally benefit a firm only if it results in an improvement in its financial performance. Fourth, measuring results in financial terms enables managers to be given more autonomy. Focusing on the outcomes of managerial actions, summarized in financial terms, gives managers the freedom to take whatever actions they consider to be appropriate to achieve the desired results. Finally, outputs expressed in financial terms continue to be effective in uncertain environments even when it is unclear what course of action should be taken. Financial results provide a mechanism to indicate whether the actions benefited the organization.

Responsibility centres

The complex environment in which most businesses operate today makes it virtually impossible for most firms to be controlled centrally. This is because it is not possible for central management to have all the relevant information and time to determine the detailed plans for all the organization. Some degree of decentralization is essential for all but the smallest firms. Organizations decentralize by creating responsibility centres. A **responsibility centre** may be defined as a unit of a firm where an individual manager is held responsible for the unit's performance. There are four types of responsibility centres. They are:

1. cost or expense centres;
2. revenue centres;
3. profit centres;
4. investment centres.

The creation of responsibility centres is a fundamental part of management accounting control systems. It is therefore important that you can distinguish between the various forms of responsibility centres.

Cost or expense centres

Cost or **expense centres** are responsibility centres whose managers are normally accountable for only those costs that are under their control. We can distinguish between two types of cost centres – standard cost centres and discretionary cost centres. The main features of **standard cost centres** are that output can be measured and the input required to produce each unit of output can be specified. Control is exercised by comparing the standard cost (that is, the cost of the inputs that *should* have been consumed in producing the output) with the cost that was *actually* incurred. The difference between the actual cost and the standard cost is described as the **variance**. Standard cost centres and variance analysis will be discussed extensively in the next chapter.

Standard cost centres are best suited to units within manufacturing firms but they can also be established in service industries such as units within banks, where output can be measured in terms of the number of cheques or the number of loan applications processed, and there are also well defined input–output relationships. Although

cost centre managers are not accountable for sales revenues they can affect the amount of sales revenue generated if quality standards are not met and outputs are not produced according to schedule. Therefore quality and timeliness non-financial performance measures are also required besides financial measures.

Discretionary expense centres are those responsibility cost centres where output cannot be measured in financial terms and there are no clearly observable relationships between inputs (the resources consumed) and the outputs (the results achieved). Control normally takes the form of ensuring that actual expenditure adheres to budgeted expenditure for each expense category and also ensuring that the tasks assigned to each centre have been successfully accomplished. Examples of discretionary centres include advertising and publicity and research and development departments. You should note that in discretionary centres underspending against budget may not necessarily be a good thing since this may result in a lower level of service than that originally planned by management. For example, underspending on research and development may indicate that the amount to be spent on research and development has not been followed. One of the major problems arising in discretionary expense centres is measuring the effectiveness of expenditures. For example, the marketing support department may not have exceeded an advertising budget but this does not mean that the advertising expenditure has been effective. The advertising may have been incorrectly timed, it may have been directed to the wrong audience, or it may have contained the wrong message. Determining the effectiveness and efficiency of discretionary expense centres is one of the most difficult areas of management control.

Revenue centres

Revenue centres are responsibility centres where managers are accountable only for financial outputs in the form of generating sales revenues. Typical examples of revenue centres are where regional sales managers are accountable for sales within their regions. Revenue centre managers may also be held accountable for selling expenses, such as salesperson salaries, commissions and order-getting costs. They are not, however, made accountable for the cost of the goods and services that they sell.

Profit centres

Both cost and revenue centre managers have limited decision-making authority. Cost centre managers are accountable only for managing inputs of their centres and decisions relating to outputs are made by other units within the firm. Revenue centres are accountable for selling the products or services but they have no control over their manufacture. A significant increase in managerial autonomy occurs when unit managers are given responsibility for both production and sales. In this situation managers are normally free to set selling prices, choose which markets to sell in, make product-mix and output decisions and select suppliers. Units within an organization whose managers are accountable for both revenues and costs are called **profit centres**.

Investment centres

Investment centres are responsibility centres whose managers are responsible for both sales revenues and costs and, in addition, have responsibility and authority to make working capital and capital investment decisions. Typical investment centre performance

measures include return on investment and economic value added. These measures are influenced by revenues, costs and assets employed and thus reflect the responsibility that managers have for both generating profits and managing the investment base. Investment centres represent the highest level of managerial autonomy. They include the company as a whole, operating subsidiaries, operating groups and divisions.

The nature of management accounting control systems

Management accounting control systems have two core elements. The first is the formal planning processes such as budgeting and long-term planning that were described in the previous chapter. These processes are used for establishing performance expectations for evaluating performance. The second is responsibility accounting which involves the creation of responsibility centres. Responsibility centres enable accountability for financial results and outcomes to be allocated to individuals throughout the organization. The objective of **responsibility accounting** is to accumulate costs and revenues for each individual responsibility centre so that the deviations from a performance target (typically the budget) can be attributed to the individual who is accountable for the responsibility centre. For each responsibility centre the process involves setting a performance target, measuring performance, comparing performance against the target, analysing the variances and taking action where significant variances exist between actual and target performance. Financial performance targets for profit or investment centres are typically in terms of profits, return on investment or economic value added whereas performance targets for cost centres are defined in terms of costs.

Responsibility accounting is implemented by issuing performance reports at frequent intervals (normally monthly) that inform responsibility centre managers of the deviations from budgets for which they are accountable and are required to take action. An example of a performance report issued to a cost centre manager is presented in the lower section of Exhibit 17.1. You should note that at successively higher levels of management less detailed information is reported. You can see from the upper sections of Exhibit 17.1 that the information is condensed and summarized as the results relating to the responsibility centre are reported at higher levels. Exhibit 17.1 only includes financial information. In addition non-financial measures such as those relating to quality and timeliness may be reported. We shall look at non-financial measures in more detail at the end of this chapter.

Responsibility accounting involves:

- distinguishing between those items which managers can control and for which they should be held accountable and those items over which they have no control and for which they are not held accountable;
- determining how challenging the financial targets should be;
- determining how much influence managers should have in the setting of financial targets.

We shall now examine each of these items in detail.

The controllability principle

Responsibility accounting is based on the application of the **controllability principle** which means that it is appropriate to charge to an area of responsibility only those

EXHIBIT 17.1

Responsibility accounting monthly performance reports

Performance report to managing director

		Budget		Variance[a] F (A)	
		Current month (£)	Year to date (£)	This month (£)	Year to date (£)
Managing director	Factory A	453 900	6 386 640	80 000(A)	98 000(A)
	Factory B	X	X	X	X
	Factory C	X	X	X	X
	Administration costs	X	X	X	X
	Selling costs	X	X	X	X
	Distribution costs	X	X	X	X
		2 500 000	30 000 000	400 000(A)	600 000(A)

Performance report to production manager of factory A

Production manager	Works manager's office	X	X	X	X
	Machining department 1	165 600	717 600	32 760(A)	89 180(A)
	Machining department 2	X	X	X	X
	Assembly department	X	X	X	X
	Finishing department	X	X	X	X
		453 900	6 386 640	80 000(A)	98 000(A)

Performance report to head of responsibility centre

Head of responsibility centre	Direct materials	X	X	X	X
	Direct labour	X	X	X	X
	Indirect labour	X	X	X	X
	Indirect materials	X	X	X	X
	Power	X	X	X	X
	Maintenance	X	X	X	X
	Idle time	X	X	X	X
	Other	X	X	X	X
		165 600	717 600	32 760(A)	89 180(A)

[a]F indicates a favourable variance (actual cost less than budgeted cost) and (A) indicates an adverse budget (actual cost greater than budget cost). Note that, at the lowest level of reporting, the responsibility centre head's performance report contains detailed information on operating costs. At successively higher levels of management less detail is reported. For example, the managing director's information on the control of activities consists of examining those variances that represent significant departures from the budget for each factory and functional area of the business and requesting explanations from the appropriate managers.

costs that are significantly influenced by the manager of that responsibility centre. The controllability principle can be implemented by either eliminating the uncontrollable items from the areas for which managers are held accountable or calculating their effects so that the reports distinguish between controllable and uncontrollable items.

Applying the controllability principle is difficult in practice because many areas do not fit neatly into either controllable and uncontrollable categories. Instead, they are partially controllable. For example, even when outcomes may be affected by occurrences outside a manager's control; such as competitors' actions, price changes and supply shortages, managers can take action to reduce their adverse effects. They can substitute alternative materials where the prices of raw materials change or they can monitor and respond to competitors' actions. If these factors are categorized as uncontrollables managers will be motivated not to try and influence them. A further problem is that even when a factor is clearly uncontrollable, it is difficult to measure in order to highlight its impact on the reported outcomes.

Dealing with the distorting effects of uncontrollable factors before the measurement period

Management can attempt to deal with the distorting effects of uncontrollables by making adjustments either before or after the measurement period. Uncontrollable and controllable factors can be determined prior to the measurement period by specifying which budget line items are to be regarded as controllable and uncontrollable. Uncontrollable items can either be excluded from performance reports or shown in a separate section within the performance report so that they are clearly distinguishable from controllable items. The latter approach has the advantage of drawing managerial attention to those costs that a company incurs to support their activities. Managers may be able to indirectly influence these costs if they are made aware of the sums involved.

How do we distinguish between controllable and uncontrollable items? Merchant suggests that the following general rule should be applied to all employees – 'Hold employees accountable for the performance areas you want them to pay attention to.' Applying this rule explains why some organizations assign the costs of shared resource pools, such as administrative costs relating to personnel and data processing departments, to responsibility centres. Assigning these costs authorizes managers of the user responsibility centres to question the amount of the costs and the quantity and quality of services supplied. In addition, responsibility centres are discouraged from making unnecessary requests for the use of these services when they are aware that increases in costs will be assigned to the users of the services.

Dealing with the distorting effects of uncontrollable factors after the measurement period

Variance analysis and flexible performance standards can be used to remove the effects of uncontrollable factors from the results measures after the measurement period. **Variance analysis** seeks to analyse the factors that cause the actual results to differ from predetermined budgeted targets. In particular, variance analysis helps to distinguish between controllable and uncontrollable items and identify those individuals who are accountable for the variances. For example, variances analysed by each type of cost, and by their price and quantity effects, enables variances to be traced to accountable



Responsibility cost control systems in China

Because of the previous lack of effective control of expenditure by the Han Dan Company a system of responsibility accounting and standard costing was introduced in 1990. The basic principles underlying the responsibility cost control system included: (1) setting cost and profit targets (responsibility standards) that take into account market pressures; (2) assigning target costs to various levels of responsibility centre; (3) evaluating performance based on fulfilment of the responsibility targets; and (4) implementing a reward scheme with built-in incentive mechanisms. In order to facilitate performance measurement and evaluation, non-controllable common costs were excluded from the responsibility costs decomposed within primary production factories. Responsibility contracts between factory managers and managers at lower levels must also be signed. Breakdown of the aggregated responsibility targets to all profit centres and their subordinates are conducted by the Department of Finance and Accounting. In addition, the department is responsible for monthly and yearly reporting of the execution results of the responsibility cost control system. It also reports and analyses the variances between actual outcomes and responsibility targets, and determines the necessary bonus rewards (or penalty) for each responsibility centre in terms of the fulfilment of the cost and profit targets signed by managers. If a responsibility centre or individual worker fails to meet the cost targets specified in the responsibility contracts, all bonus and other benefits relating to the responsibility unit or worker will be forfeited.

Source: Adapted from Z. Jun Lin and Z. Yu (2002), Responsibility cost control system in China: a case of management accounting application, *Management Accounting Research*, Vol. 13, No. 4, pp. 447–67.

individuals and also to isolate those variances that are due to uncontrollable factors. Variance analysis will be discussed extensively in the next chapter.

Flexible performance standards apply when targets are adjusted to reflect variations in uncontrollable factors arising from the circumstances not envisaged when the targets were set. The most widely used flexible performance standard is to use **flexible budgets** whereby the uncontrollable volume effects on cost behaviour are removed from the manager's performance reports. Because some costs vary with changes in the level of activity, it is essential when applying the controllability principle to take into account the variability of costs. For example, if the actual level of activity is greater than the budgeted level of activity then those costs that vary with activity will be greater than the budgeted costs purely because of changes in activity. Let us consider the simplified situation presented in Example 17.1.

Assuming that the increase in activity was due to an increase in sales volume greater than that anticipated when the budget was set then the increases in costs arising from the volume change are beyond the control of the responsibility centre manager. It is clearly inappropriate to compare actual *variable* costs of £105 000 from an activity level of 24 000 units with budgeted *variable* costs of £100 000 from an activity level of 20 000 units. This would incorrectly suggest an overspending of £5000. If managers are to be made responsible for their costs, it is essential that they are responsible for performance under the conditions in which they worked, and not for a performance based on conditions when the budget was drawn up. In other words, it is

EXAMPLE 17.1

An item of expense that is included in the budget for a responsibility centre varies directly in relation to activity at an estimated cost of £5 per unit of output. The budgeted monthly level of activity was 20 000 units and the actual level of activity was 24 000 units at a cost of £105 000.

misleading to compare actual costs at one level of activity with budgeted costs at another level of activity. At the end of the period the original budget must be adjusted to the actual level of activity to take into account the impact of the uncontrollable volume change on costs. This procedure is called flexible budgeting. In Example 17.1 the performance report should be as follows:

Budgeted expenditure	Actual expenditure
(flexed to 24 000 units)	(24 000 units)
£120 000	£105 000

The budget is adjusted to reflect what the costs should have been for an actual activity of 24 000 units. This indicates that the manager has incurred £15 000 less expenditure than would have been expected for the actual level of activity, and a favourable variance of £15 000 should be recorded on the performance report, not an adverse variance of £5000, which would have been recorded if the original budget had not been adjusted.

In Example 17.1 it was assumed that there was only one variable item of expense, but in practice the budget will include many different expenses including fixed, semi-variable and variable expenses. You should note that fixed expenses do not vary in the short-term with activity and therefore the budget should remain unchanged for these expenses. The budget should be flexed only for variable and semi-variable expenses.

Guidelines for applying the controllability principle

Dealing with uncontrollables represents one of the most difficult areas for the design and operation of management accounting control systems. The following guidelines published by the Report of the Committee of Cost Concepts and Standards in the United States in 1956 still continues to provide useful guidance:

1. If a manager *can control the quantity and price paid* for a service then the manager is responsible for all the expenditure incurred for the service.
2. If the manager *can control the quantity of the service but not the price paid* for the service then only that amount of difference between actual and budgeted expenditure that is due to usage should be identified with the manager.
3. If the manager *cannot control either the quantity or the price paid* for the service then the expenditure is uncontrollable and should not be identified with the manager.

An example of the latter situation is when the costs of an industrial relations department are apportioned to a department on some arbitrary basis; such arbitrary apportionments are likely to result in an allocation of expenses that the managers of

responsibility centres may not be able to influence. In addition to the above guidelines Merchants's general rule should also be used as a guide – 'Hold employees accountable for the performance areas you want them to pay attention to.'

Setting financial performance targets

There is substantial evidence from a large number of studies that the existence of a defined, quantitative goal or target is likely to motivate higher levels of performance than when no such target is stated. People perform better when they have a clearly defined goal to aim for and are aware of the standards that will be used to interpret their performance. There are three approaches that can be used to set financial targets. They are targets derived from engineering studies of input–output relationships, targets derived from historical data and targets derived from negotiations between superiors and subordinates.

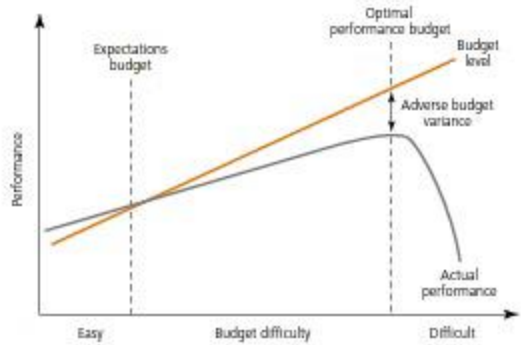
Engineered targets can be used when there are clearly defined and stable input–output relationships such that the inputs required can be estimated directly from product specifications. For example, in a fast-food restaurant for a given output of hamburgers it is possible to estimate the inputs required because there is a physical relationship between the ingredients such as meats, buns, condiments and packaging and the number of hamburgers made. Input–output relationships can also be established for labour by closely observing the processes to determine the quantity of labour that will be required for a given output.

Where clearly defined input–output relationships do not exist other approaches must be used to set financial targets. One approach is to use **historical targets** derived directly from the results of previous periods. Previous results plus an increase for expected price changes may form the basis for setting the targets or an improvement factor may be incorporated into the estimate, such as previous period costs less a reduction of 10%. The disadvantage of using historical targets is that they may include past inefficiencies or may encourage employees to underperform if the outcome of efficient performance in a previous period is used as a basis for setting a more demanding target in the next period.

Negotiated targets are set based on negotiations between superiors and subordinates. The major advantage of negotiated targets is that they address the information asymmetry gap that can exist between superior and subordinate. This gap arises because subordinates have more information than their superiors on the relationships between outputs and inputs and the constraints that exist at the operating level, whereas superiors have a broader view of the organization as a whole and the resource constraints that apply. Negotiated targets enable the information asymmetry gap to be reduced so that the targets set incorporate the constraints applying at both the operational level and the firm as a whole. You should refer back to the previous chapter for a more detailed discussion of the negotiation process.

Targets vary in their level of difficulty and the chosen level has a significant effect on motivation and performance. Targets are considered to be moderately difficult (or highly achievable) when they are set at the average level of performance for a given task. According to Merchant (1990) most companies set their annual profit budgets targets at levels that are highly achievable. Their budgets are set to be challenging but achievable 80–90 per cent of the time by an effective management team working at a consistently high level of effort. Targets set at levels above average are labelled as difficult, tight or high, and those set below average are classed as easy, loose or low (Chow, 1983).

FIGURE 17.2 *The effect of budget difficulty on performance. Source: Otley (1987)*



The effect of the level of budget difficulty on motivation and performance

The fact that a financial target represents a specific quantitative goal gives it a strong motivational potential, but the targets set must be accepted if managers are to be motivated to achieve higher levels of performance. Unfortunately, it is not possible to specify exactly the optimal degree of difficulty for financial targets, since task uncertainty and cultural, organizational and personality factors all affect an individual manager's reaction to a financial target.

Figure 17.2, derived from Otley (1987), shows the theoretical relationship between budget difficulty, aspiration levels and performance. In Figure 17.2 it is assumed that performance and aspiration levels are identical. Note that the **aspiration level** relates to the personal goal of the budgetee (that is, the person who is responsible for the budget). In other words, it is the level of performance that they hope to attain. You will see from Figure 17.2 that as the level of budget difficulty is increased both the budgetees' aspiration level and performance increases. However, there becomes a point where the budget is perceived as impossible to achieve and the aspiration level and performance decline dramatically. It can be seen from Figure 17.2 that the budget level that motivates the best level of performance may not be achievable. In contrast, the budget that is expected to be achieved (that is, the expectations budget in Figure 17.2) motivates a lower level of performance.

To motivate the best level of actual performance, demanding budgets should be set and small adverse variances should be regarded as a healthy sign and not as something to be avoided. If budgets are always achieved with no adverse variances, this indicates that the standards are too loose to motivate the best possible results.

Participation in the budgeting and target-setting process

Participation relates to the extent that subordinates or budgetees are able to influence the figures that are incorporated in their budgets or targets. Participation is sometimes referred to as **bottom-up budget setting** whereas a non-participatory approach whereby subordinates have little influence on the target-setting process is sometimes called **top-down budget setting**.

Allowing individuals to participate in the setting of performance targets has several advantages. First, individuals are more likely to accept the targets and be committed to achieving them if they have been involved in the target-setting process. Second, participation can reduce the information asymmetry gap that applies when standards are imposed from above. Subordinates have more information than their superiors on the relationships between outputs and inputs and the constraints that exist at the operating level whereas the superiors have a broader view of the organization as a whole and the resource constraints that apply. This information sharing process enables more effective targets to be set that attempt to deal with both operational and organizational constraints. Finally, imposed standards can encourage negative attitudes and result in demotivation and alienation. This in turn can lead to a rejection of the targets and poor performance.

Participation has been advocated by many writers as a means of making tasks more challenging and giving individuals a greater sense of responsibility. For many years participation in decision-making was thought to be a panacea for effective organizational effort but this school of thought was later challenged. The debate has never been resolved. The believers have never been able to demonstrate that participation really does have a positive effect on productivity and the sceptics have never been able to prove the opposite (Macintosh, 1985). The empirical studies have presented conflicting evidence on the usefulness of participation in the management process. For every study indicating that participation leads to better attitudes and improved performance, an alternative frequently exists suggesting the opposite.

Because of the conflicting findings relating to the effectiveness of participation research has tended to concentrate on studying how various factors influence the effectiveness of participation. Hopwood (1978) identified the importance of the work situation in determining the appropriateness of participation. He states:

> *In highly programmed, environmentally and technologically constrained areas, where speed and detailed control are essential for efficiency, participative approaches may have much less to offer from the point of view of the more economic aspects of organizational effectiveness … In contrast, in areas where flexibility, innovation and the capacity to deal with unanticipated problems are important, participation in decision-making may offer a more immediate and more narrowly economic payoff than more authoritarian styles.*

The evidence from the various studies suggests that participative styles of management will not necessarily be more effective than other styles, and that participative methods should be used with care. It is therefore necessary to identify those situations where there is evidence that participative methods are effective, rather than to introduce universal application into organizations. Participation must be used selectively; but if it is used in the right circumstances, it has an enormous potential for encouraging the commitment to organizational goals, improving attitudes towards the budgeting system, and increasing subsequent performance. Note, however, at this stage that participation does suffer from the limitation that performance is measured by precisely the same standard that the budgetee has been involved in setting. This

gives the budgetee the opportunity to negotiate lower targets that increase the probability of target achievement and the accompanying rewards. Therefore an improvement in performance – in terms of comparison with the budget – may result merely from a lowering of the standard. Ideally external reference points should be available, since this can provide an indication as to whether the participation process leads to low performance because of loose standards.

Non-financial performance measures

Earlier in this chapter it was pointed out that performance reports (such as the one illustrated in Exhibit 17.1) should not include only financial measures. In addition, non-financial measures should also be reported. There is a danger that if performance reports include only those items which can be expressed in monetary terms, managers will concentrate on only these variables and ignore other important variables that cannot easily be quantified in monetary terms. It is always possible to obtain short-term improvements in cost control by hierarchical pressure to cut costs and raise productivity, but this will eventually have negative effects on managerial performance in the form of adverse motivational changes, increased labour turnover and reduced product quality. The problem is that reductions in costs are measured and included in performance reports, but the state of the morale of a department cannot easily be measured. Performance reports should therefore be broadened to incorporate other variables besides costs and revenues. Unfortunately, performance reports based only on costs and revenues do not give a sufficient indication of the future results that can be expected from present actions.

Financial summaries of performance provide only a limited view of the efficiency and effectiveness of actual operations. Consider a situation where a purchasing department regularly achieved the budget for all expense items. The message from a responsibility performance reporting system that incorporates only financial measures suggests that the department was well managed. However, the department provided a poor service to the production departments. Low-cost suppliers were selected who provide poor-quality materials and frequently failed to meet delivery dates. This caused much wasted effort in chasing up orders and prejudiced the company's ability to deliver to its customers on time. To evaluate the performance of the department there is clearly a need to incorporate non-financial measures that provide information on the quality of the service provided by the department.

In recent years there has been a shift from treating financial figures as the foundation for performance measurement and control to treating them as one among a broader set of measures. In today's worldwide competitive environment companies are competing in terms of product quality, delivery, reliability, after-sales service and customer satisfaction. None of these variables is directly measured by responsibility performance reporting systems that rely solely on financial measures, despite the fact that they represent major goals of world-class manufacturing companies. By focusing mainly on measuring costs, there is a danger that the performance reporting system will motivate managers to focus exclusively on cost reduction and ignore other important strategic manufacturing goals.

The changes described above have resulted in much greater emphasis being placed on non-financial performance measures that provide feedback on the key variables required to compete successfully in today's competitive environment. These non-financial measures focus on such factors as quality, reliability, flexibility and delivery performance. Such factors are seen as increasingly crucial in today's competitive environment.

Activity-based cost management



The content covered in this section may only be applicable to second-level courses. Please check your course content to ascertain if you need to read this section. So far in this chapter the major features of traditional management accounting control systems and the mechanisms that can be used to control costs have been described. Traditional management accounting control systems focus mainly on comparing actual results against a preset standard (typically the budget), identifying and analysing variances and taking remidial action to ensure that future outcomes conform with budgeted outcomes. Traditional systems have been criticized because they tend to be based on the preservation of the status quo and the ways of performing existing activities are not reviewed. The emphasis is on cost containment rather than cost reduction.

During the 1990s increasing emphasis has been given to **cost management**, where the focus is on cost reduction and continuous improvement and change, rather than cost containment. Whereas traditional cost control systems are routinely applied on a continuous basis, cost management tends to be applied on an ad hoc basis when an opportunity for cost reduction is identified. Cost management consists of those actions that are taken by managers to reduce costs, some of which are prioritized on the basis of information extracted from an ABC system.

The early adopters of activity-based costing (ABC) used it to produce more accurate product (or service) costs but it soon became apparent to the users that it could be extended beyond purely product costing to a range of cost management applications. The terms **activity-based management (ABM)** or **activity-based cost management (ABCM)** are used to describe the cost management applications of ABC. To implement an ABM system only the first three of the four stages described in Chapter 13 for designing an activity-based product costing system are required. They are:

1. identifying the major activities that take place in an organization;
2. assigning costs to cost pools/cost centres for each activity;
3. determining the cost driver for each major activity.

Thus, firms can omit the final stage of assigning activity costs to products and adopt ABC solely for cost management without activity-based product costing. Alternatively, organizations can design an activity-based system that incorporates both ABM and activity-based product costing, but note that only the first three stages are required for ABM.

ABM views the business as a set of linked activities that ultimately add value to the customer. It focuses on managing the business on the basis of the activities that make up the organization. ABM is based on the premise that activities consume costs. Therefore by managing activities costs will be managed in the long term. The goal of ABM is to enable customer needs to be satisfied while making fewer demands on organizational resources. Besides providing information on what activities are performed, ABM provides information on the cost of activities, why the activities are undertaken, and how well they are performed.

Traditional budget and control reports analyse costs by types of expense for each responsibility centre. In contrast, ABM analyses costs by activities and thus provides management with information on why costs are incurred and the output from the activity (in terms of cost drivers). Exhibit 17.2 illustrates the difference between the conventional analysis and the activity-based analysis in respect of customer order

EXHIBIT 17.2
Customer order processing activity

	(£000s)
Traditional analysis	
Salaries	320
Stationery	40
Travel	140
Telephone	40
Depreciation of equipment	40
	580
ABM analysis	
Preparing quotations	120
Receiving customer orders	190
Assessing the creditworthiness of customers	100
Expediting	80
Resolving customer problems	90
	580

processing. The major differences are that the ABM approach reports by *activities* whereas the traditional analysis is by *departments*. Also ABM reporting is by sub-activities but traditional reporting is by expense categories. Another distinguishing feature of ABM reporting is that it often reports information on activities that cross departmental boundaries. For example, different production departments and the distribution department might undertake customer processing activities. They may resolve customer problems by expediting late deliveries. The finance department may assess customer credit worthiness and the remaining customer processing activities might be undertaken by the customer service department. Therefore the total cost of the customer processing activity could be considerably in excess of the costs that are assigned to the customer service department. However, to simplify the presentation it is assumed in Exhibit 17.2 that the departmental and activity costs are identical but if the cost of the customer order processing activity was found to be, say, three times the amount assigned to the customer service department, this would be important information because it may change the way in which the managers view the activity. For example, the managers may give more attention to reducing the costs of customer processing activity.

It is apparent from an examination of Exhibit 17.2 that the ABM approach provides more meaningful information. It gives more visibility to the cost of undertaking the activities that make up the organization and may raise issues for management action that are not highlighted by the traditional analysis. For example, why is £90 000 spent on resolving customer problems? Attention-directing information such as this is important for managing the cost of the activities.

Johnson (1990) suggests that knowing costs by activities is a catalyst that eventually triggers the action necessary to become competitive. Consider a situation where salespersons, as a result of costing activities, are informed that it costs £50 to process a customer's order. They therefore become aware that it is questionable to pursue orders with a low sales value. By eliminating many small orders, and concentrating on larger value orders, the demand for customer-processing activities should decrease, and future spending on this activity should be reduced.

Prior to the introduction of ABM most organizations have been unaware of the cost of undertaking the activities that make up the organization. Knowing the cost of activities enables those activities with the highest cost to be highlighted so that they can be prioritized for detailed studies to ascertain whether they can be eliminated or performed more efficiently. To identify and prioritize the potential for cost reduction many organizations have found it useful to classify activities as either value added or non-value added. Definitions of what constitutes value added and non-value added activities vary. A common definition is that a **value added activity** is an activity that customers perceive as adding usefulness to the product or service they purchase. For example, painting a car would be a value added activity in an organization that manufactures cars. Other definitions are an activity that is being performed as efficiently as possible or an activity that supports the primary objective of producing outputs.

In contrast, a **non-value added activity** is an activity where there is an opportunity for cost reduction without reducing the product's service potential to the customer. Examples of non-value added activities include inspecting, storing and moving raw materials. The cost of these activities can be reduced without reducing the value of the products to the customers. Non-value added activities are essentially those activities that customers should not be expected to pay for. Reporting the cost of of non-value added activities draw management's attention to the vast amount of waste that has been tolerated by the organization. This should prioritize those activities with the greatest potential for cost reduction by eliminating or carrying them out more effectively, such as reducing material movements, improving production flows and taking actions to reduce stock levels. Taking action to reduce or eliminate non-value added activities is given top priority because by doing so the organization permanently reduces the cost it incurs without reducing the value of the product to the customer.



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Describe the three different types of controls used in organizations.**

  Three different categories of controls are used – action/behavioural controls, personnel and cultural controls and results/output controls. With action controls the actions themselves are the focus of controls. They are usable and effective only when managers know what actions are desirable (or undesirable) and have the ability to make sure that the desirable actions occur (or that the undesirable actions do not occur). Personnel controls help employees do a good job by building on employees' natural tendencies to control themselves. They include selection and placement, training and job design. Cultural controls represent a set of values, social norms and beliefs that are shared by members of the organization and that influence their actions. Output or results controls involve collecting and reporting information about the outcomes of work effort. They involve the following stages – establishing results and performance targets, measuring performance and providing rewards or punishments based on an employee's ability to achieve the performance target.

- **Describe a cybernetic control system.**

  The traditional approach in the management control literature has been to view results controls as a simple cybernetic system. A cybernetic control system resembles the thermostat control model. Standards of performance are determined, measurement

systems monitor performance, comparisons are made between the standard and actual performance and feedback provides information on the variances between standard and actual performance of the actions that are being measured.

- **Distinguish between feedback and feed-forward controls.**

  Feedback control involves monitoring outputs achieved against desired outputs and taking whatever corrective action is necessary if a deviation exists. In feed-forward control, instead of actual outputs being compared against desired outputs, predictions are made of what outputs are expected to be at some future time. If these expectations differ from what is desired, control actions are taken that will minimize these differences. The objective is for control to be achieved before any deviations from desired outputs actually occur. The budgeting process is a feed-forward control system. The comparison of actual results with budget, in identifying variances and taking remedial action to ensure future outcomes will conform with budgeted outcomes, is an illustration of a feedback control system.

- **Define the four different types of responsibility centres.**

  A responsibility centre may be defined as a unit of a firm where an individual manager is held accountable for the unit's performance. There are four types of responsibility centres – cost or expense centres, revenue centres, profit centres and investment centres. Cost or expense centres are responsibility centres whose managers are normally accountable for only those costs that are under their control. Revenue centres are responsibility centres where managers are accountable only for financial outputs in the form of generating sales revenues. Typical examples of revenue centres are where regional sales managers are accountable for sales within their regions. Both cost and revenue centre managers have limited decision-making authority. A significant increase in managerial autonomy occurs when unit managers are given responsibility for both production and sales. In this situation, managers are normally free to set selling prices, choose which markets to sell in, make product mix and output decisions and select suppliers. Units within an organization whose managers are accountable for both revenues and costs are called profit centres. Investment centres are responsibility centres whose managers are responsible for both sales revenues and costs and, in addition, have responsibility and authority to make working capital and capital investment decisions.

- **Explain the different elements of management accounting control systems.**

  Management accounting control systems have two core elements. The first is the formal planning processes such as budgeting and long-term planning. These processes are used for establishing performance expectations for evaluating performance. The second is responsibility accounting, which involves the creation of responsibility centres. Responsibility centres enable accountability for financial results/outcomes to be allocated to individuals throughout the organization. Responsibility accounting involves: (a) distinguishing between those items which managers can control and for which they should be held accountable and those items over which they have no control and for which they are not held accountable; (b) determining how challenging the financial targets should be; and (c) determining how much influence managers should have in the setting of financial targets.

- **Describe the controllability principle and the methods of implementing it.**

  The controllability principle states that it is appropriate to charge to an area of responsibility only those costs that are significantly influenced by the manager of that responsibility centre. The controllability principle can be implemented by

either eliminating the uncontrollable items from the areas that managers are held accountable for or calculating their effects so that the reports distinguish between controllable and uncontrollable items.

- **Describe the different approaches that can be used to determine financial performance targets and discuss the impact of their level of difficulty on motivation and performance.**

  There are three approaches that can be used to set financial targets. They involve targets derived from engineering studies of input–output relationships, targets derived from historical data and targets derived from negotiations between superiors and subordinates. Engineered targets can be used when there are clearly defined and stable input–output relationships such that the inputs required can be estimated directly from product specifications. Where clearly defined input–output relationships do not exist other approaches must be used to set financial targets. One approach is to use historical targets derived directly from the results of previous periods. Previous results plus an increase for expected price changes may form the basis for setting the targets or an improvement factor may be incorporated into the estimate. Negotiated targets are set based on negotiations between superiors and subordinates. Different types of financial performance targets can be set ranging from easily achievable to difficult to achieve. Targets that are considered moderately difficult to achieve (called highly achievable targets) are recommended because they can be used for planning purposes and they also have a motivational impact.

- **Describe the influence of participation in the budgeting process.**

  Participation relates to the extent that budgetees are able to influence the figures that are incorporated in their budgets or targets. Allowing individuals to participate in the setting of performance targets has the following advantages: (a) individuals are more likely to accept the targets and be committed to achieving them if they have been involved in the target setting process; (b) participation can reduce the information asymmetry gap that applies when standards are imposed from above; and (c) imposed standards can encourage negative attitudes and result in demotivation and alienation. Participation, however, is subject to the limitation that performance is measured by precisely the same standard that the budgetee has been involved in setting. Participation must be used selectively; but if it is used in the right circumstances, it has an enormous potential for encouraging the commitment to organizational goals.

- **Explain why a performance measurement system should also incorporate non-financial measures.**

  There is a danger that if performance reports include only those items which can be expressed in monetary terms, managers will concentrate only on these variables and ignore other measures that are critical to the long-term success of the business. Key non-financial measures should be incorporated into the performance measurement systems that focus on areas such as competitiveness, product leadership, productivity, quality, delivery performance and innovation. If managers focus excessively on financial measures there is a danger that short-term performance will be emphasized at the expense of long-term performance.

- **Describe activity-based cost management.**

  Activity-based management (ABM) focuses on managing the business on the basis of the activities that make up the organization. It is based on the premise that activities consume costs. Therefore by managing activities costs will be managed in the long term. The goal of ABM is to enable customer needs to be satisfied while

making fewer demands on organization resources. Prior to the introduction of ABM most organizations have been unaware of the cost of undertaking the activities that make up the organization. Knowing the cost of activities enables those activities with the highest cost to be highlighted so that they can be prioritized for detailed studies to ascertain whether they can be eliminated or performed more efficiently.

- **Additional learning objective presented in Appendix 17.1.**

The appendix to this chapter includes an additional learning objective: to explain the meaning of return on investment (ROI) and residual income. ROI expresses divisional profit as a percentage of the assets employed in a division. Residual income is defined as divisional profit less a cost of capital charge on divisional investment (e.g. net assets or total assets). You should note that these topics are generally covered on second level cost and management accounting courses. However, some of the professional accounting examination bodies have begun to examine this topic on first level courses. You should therefore check your course content to ascertain if you need to read Appendix 17.1.

Appendix 17.1: Responsibility accounting in profit and investment centres



In the main body of this chapter it was pointed out that responsibility centres are established to enable accountability for financial results and outcomes to be allocated to individuals throughout the organization. Responsibility accounting for cost centres accumulates costs for each individual responsibility centre so that deviations from a target (typically the budget) can be attributed to the individual who is accountable for the responsibility centre. Many organizations establish divisionalized organizational structures consisting of separate divisions that are either profit or investment centres. Within each division, decentralization takes place by establishing multiple responsibility cost and revenue centres whereby lower level managers are accountable for the difference between budgeted and actual outcomes. At the top divisional management level, corporate management makes the divisional managers accountable for the overall performance of the divisions. In this appendix measures that are used to evaluate the financial performance of the divisions are described.

Return on investment

Instead of focusing purely on the absolute size of a division's profits most organizations focus on the **return on investment (ROI)** of a division. Note also that ROI is also referred to as **return on capital employed** or **accounting rate of return**. ROI expresses divisional profit as a percentage of the assets employed in a division. Why is ROI the most widely used financial measure of divisional performance? Consider a situation where division A earns a profit of £1 million and division B a profit of £2 million. Can we conclude that Division B is more profitable than Division A? The answer is no, since we should consider whether the divisions are returning a sufficiently high return on the capital invested in the division. Assume that £4 million capital is invested in division A and £20 million in division B.

Division A's ROI is 25% (£1m/£4m) whereas the return for division B is 10% (£2m/£20m). Capital invested has alternative uses, and corporate management will wish to ascertain whether the returns being earned on the capital invested in a particular division exceeds the division's opportunity cost of capital (i.e. the returns available from the alternative use of the capital). If, in the above illustration, the return available on similar investments to that in division B is 15% then the economic viability of division B is questionable if profitability cannot be improved. In contrast, the ROI measure suggests that division A is very profitable.

A major attraction of ROI is that it can be used as a common denominator for comparing the returns of dissimilar businesses, such as other divisions within the group or outside competitors. ROI has been widely used for many years in all types of organizations so that most managers understand what the measure reflects and consider it to be of considerable importance.

Despite the widespread use of ROI, a number of problems exist when this measure is used to evaluate the performance of divisional managers. For example, it is possible that divisional ROI can be increased by actions that will make the company as a whole worse off, and conversely, actions that decrease the divisional ROI may make the company as a whole better off. In other words, evaluating divisional managers on the basis of ROI may not encourage **goal congruence** (i.e. when the controls motivate employees to engage in behaviour that is organizationally desirable). Consider the following example:

	Division X	Division Y
Investment project available	£10 million	£10 million
Divisional profit contribution	£2 million	£1.3 million
Return on the proposed project	20%	13%
ROI of divisions at present	25%	9%

It is assumed that the overall cost of capital for the company is 15%. The manager of division X would be reluctant to invest the additional £10 million because the return on the proposed project is 20%, and this would reduce the existing overall ROI of 25%. On the other hand, the manager of division Y would wish to invest the £10 million because the return on the proposed project of 13% is in excess of the present return of 9%, and it would increase the division's overall ROI. Consequently, the managers of both divisions would make decisions that would not be in the best interests of the company. The company should accept only those projects where the return is in excess of the cost of capital of 15%, but the manager of division X would reject a potential return of 20% and the manager of division Y would accept a potential return of 13%. ROI can therefore lead to a lack of goal congruence.

Residual income

To overcome some of the dysfunctional consequences of ROI, the residual income approach can be used. **Residual income** is defined as divisional profit contribution less a cost of capital charge on the divisional investment (i.e. the assets employed in the division). If residual income is used to measure the managerial performance of investment centres, there is a greater probability that managers will be encouraged, when acting in their own best interests, also to act in the best interests of the company. Returning to our previous illustration in respect of the investment decision for divisions X and Y, the residual income calculations are as follows:

	Division X (£)	Division Y (£)
Proposed investment	10 million	10 million
Divisional profit contribution	2 million	1.3 million
Cost of capital charge (15% of the investment cost)	1.5 million	1.5 million
Residual income	0.5 million	– 0.2 million

This calculation indicates that the residual income of division X will increase and that of division Y will decrease if both managers accept the project. Therefore the manager of division X would invest, whereas the manager of division Y would not. These actions are in the best interests of the company as a whole.

Residual income suffers from the disadvantages of being an absolute measure, which means that it is difficult to compare the performance of a division with that of other divisions or companies of a different size. For example, a large division is more likely to earn a larger residual income than a small division. To overcome this deficiency, targeted or budgeted levels of residual income should be set for each division that are consistent with asset size and the market conditions of the divisions.

Surveys of methods used by companies to evaluate the performance of divisional managers (e.g. Drury *et al.* (1993)) indicate a strong preference for ROI over residual income. Why is ROI preferred to residual income? Skinner (1990) found evidence to suggest that firms prefer to use ROI because, being a ratio, it can be used for inter-division and inter-firm comparisons. ROI for a division can be compared with the return from other divisions within the group or with whole companies outside the group, whereas absolute monetary measures such as residual income are not appropriate in making such comparisons. A second possible reason for the preference for ROI is that 'outsiders' tend to use ROI as a measure of a company's overall performance. Corporate managers therefore want their divisional managers to focus on ROI so that their performance measure is congruent with outsiders' measure of the company's overall economic performance.

During the early 1990s Stern Stewart and Co., a New York-based consulting firm, repackaged and refined residual income in the form of **economic valued added®** (EVA®). The EVA concept extends the traditional residual income measure by incorporating adjustments to the divisional financial performance measure for distortions introduced by following financial accounting requirements (i.e. generally accepted accounting principles known as GAAP). EVA can be defined as:

$$\text{EVA} = \text{Conventional divisional profit} \pm \text{accounting adjustments} - \text{cost of capital charge on divisional assets}$$

A discussion of EVA is beyond the scope of this book. You should refer to Drury (2004, ch. 20) for a discussion of this topic.



Key terms and concepts

accounting rate of return (p. 477)
action controls (p. 456)
activity-based cost management (p. 472)
activity-based management (p. 472)
aspiration level (p. 469)
behavioural controls (p. 456)
bottom-up budget setting (p. 469)
clan controls (p. 457)
control (p. 455)
controllability principle (p. 463)
controls (p. 455)
cost centres (p. 461)
cost management (p. 472)
cultural controls (p. 458)
cybernetic system (p. 459)
discretionary expense centres (p. 462)
economic-value added (p. 479)
engineered targets (p. 468)
expense centres (p. 461)
feedback control (p. 460)
feed-forward control (p. 460)
flexible budgets (p. 466)
goal congruence (p. 478)
historical targets (p. 468)
investment centres (p. 462)
negotiated targets (p. 468)
non-value added activity (p. 474)
output controls (p. 458)
participation (p. 469)
personnel controls (p. 457)
profit centres (p. 462)
residual income (p. 478)
responsibility accounting (p. 463)
responsibility centre (p. 461)
results controls (p. 458)
return on capital employed (p. 477)
return on investment (p. 477)
revenue centres (p. 462)
social control (p. 457)
standard cost centres (p. 461)
top-down budget setting (p. 469)
value-added activity (p. 474)
variance (p. 461)
variance analysis (p. 465)

Key examination points

Essay questions are extensively used in second year management accounting courses. They tend not to be widely used for first year courses. The most frequently examined topic on first year courses is to prepare flexible budgets (see solutions to Review problems 17.23, 17.24 and 17.26). If you are required to prepare flexible budgets remember to flex the budget on the basis of target cost for actual output rather than input measures, such as direct labour or input hours. Also questions requiring you to comment on, or redraft performance reports, are sometimes set (e.g. Review problem 17.25). It is important that you distinguish between controllable and non-controllable expenses and stress the need to incorporate non-financial measures. A common error is to compare actual performance with an unflexed budget.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

Review questions

17.1 Distinguish between 'controls' and 'control'. (*pp. 455–6*)

17.2 Identify and describe three different types of control mechanisms used by companies. (*pp. 456–9*)

17.3 Provide examples of behavioural, action, social, personnel and cultural controls. (*pp. 456–9*)

17.4 Describe the different stages that are involved with output/results controls. (*pp. 458–9*)

17.5 Describe the elements of cybernetic control systems. How do they relate to results/output controls? (*p. 459*)

17.6 Distinguish between feedback and feed-forward controls. Provide an example of each type of control. (*p. 460*)

17.7 Describe the four different types of responsibility centres. (*pp. 461–3*)

17.8 Explain what is meant by the term 'responsibility accounting'. (*p. 463*)

17.9 What factors must be taken into account when operating a responsibility accounting system? (*p. 463*)

17.10 What is the 'controllability principle'? Describe the different ways in which the principle can be applied. (*pp. 463–7*)

17.11 What are flexible budgets? Why are they preferred to fixed (static budgets)? (*pp. 466–7*)

17.12 What is meant by the term 'aspiration level'? (*p. 469*)

17.13 Describe the effect of the level of budget difficulty on motivation and performance. (*p. 469*)

17.14 Distinguish between participation and top-down budget setting. (*p. 469*)

17.15 Describe the factors influencing the effectiveness of participation in the budget process. (*pp. 470–1*)

17.16 What are the limitations of participation in the budget process? (*pp. 470–1*)

17.17 Distinguish between return on investment residual income and economic value added. (*pp. 477–9*)

17.18 How does the use of return on investment performance measure lead to bad decisions? How do residual income and economic value added overcome these problems? (*pp. 477–9*)

Review problems

17.19 The following statements relate to performance evaluation methods:

(i) Residual income is not a relative measure.
(ii) The return on investment figure is a relative measure.
(iii) Residual income cannot be calculated for an individual project.

Which of the above are correct?

A (i) and (ii) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

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17.20 A company wishes to evaluation a division which has the following profit and loss account and balance sheet:

Profit and loss account	£000
Sales	500
Gross profit	200
Other costs	(80)
Net profit	120

Balance sheet	£000
Fixed assets	750
Current assets	350
Current liabilities	(450)
Net assets	650

What is the residual income for the division if the company has a cost of capital of 18%?

A £3000
B £21 600
C £83 000
D £117 000

ACCA Paper 1.2 – Financial Information for Management

17.21 Bollon uses residual income to appraise its divisions using a cost of capital of 10%. It gives the managers of these divisions considerable autonomy although it retains the cash control function at head office.

The following information was available for one of the divisions:

	Net profit after tax £'000	Profit before interest and tax £'000	Divisional net assets £'000	Cash/ (overdraft) £'000
Division 1	47	69	104	(21)

What is the residual income for this division based on controllable profit and controllable net assets?

A £36 600
B £56 500
C £58 600
D £60 700.

ACCA Paper 1.2 – Financial Information for Management

17.22 Division Q makes a single product. Information for the division for the year just ended is:

Sales	30 000 units
Fixed costs	£487 000
Depreciation	£247 500
Residual income	£47 200
Net assets	£1 250 000

Head Office assesses divisional performance by the residual income achieved. It uses a cost of capital of 12% a year.

Division Q's average contribution per unit was

A £14.82
B £22.81
C £28.06
D £31.06
E £32.81

(2 marks)
CIMA Management Accounting – Decision Making

17.23 Flexible budgets and variance analysis

A company has obtained the following information regarding costs and revenue for the past financial year:

Original budget:	
Sales	10 000 units
Production	12 000 units

Standard cost per unit:

	£
Direct materials	5
Direct labour	9
Fixed production overheads	8
	22
Selling price	30

Actual results:	
Sales	9750 units
Revenue	£325 000
Production	11 000 units
Material cost	£65 000
Labour cost	£100 000
Fixed production overheads	£95 000

There were no opening stocks.

Required:

(a) Produce a flexed budget statement showing the flexed budget and actual results. Calculate the variances between the actual and flexed figures for the following:

- sales;
- materials;
- labour; and
- fixed production overhead.

(7 marks)

(b) Explain briefly how the sales and materials variances calculated in (a) may have arisen.

(3 marks)
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17.24 Fixed and flexible budgets

(a) Explain what is meant by the terms 'fixed budget' and 'flexible budget', and state the main objective of preparing flexible budgets.

(5 marks)

(b) (i) Prepare a flexible budget for 20X5 for the overhead expenses of a production department at the activity levels of 80%, 90% and 100%, using the information listed below.

(12 marks)

1. The direct labour hourly rate is expected to be £3.75.
2. 100% activity represents 60 000 direct labour hours.
3. Variable costs:

Indirect labour	£0.75 per direct labour hour
Consumable supplies	£0.375 per direct labour hour
Canteen and other welfare services	6% of direct *and* indirect labour costs

4. Semi-variable costs are expected to correlate with the direct labour hours in the same manner as for the last five years, which was:

Year	Direct labour hours	Semi-variable costs (£)
20X0	64 000	20 800
20X1	59 000	19 800
20X2	53 000	18 600
20X3	49 000	17 800
20X4	40 000 (estimate)	16 000 (estimate)

5. Fixed costs:

	(£)
Depreciation	18 000
Maintenance	10 000
Insurance	4 000
Rates	15 000
Management salaries	25 000

6. Inflation is to be ignored.

(ii) Calculate the budgets cost allowance for 20X5 assuming that 57 000 direct labour hours are worked.

(3 marks)
(Total 20 marks)
CIMA Cost Accounting 1

17.25 Comments on a performance report

The Victorial Hospital is located in a holiday resort that attracts visitors to such an extent that the population of the area is trebled for the summer months of June, July and August. From past experience, this influx of visitors doubles the activity of the hospital during these months. The annual budget for the hospital's laundry department is broken down into four quarters, namely April–June, July–September, October–December and

January–March, by dividing the annual budgeted figures by four. The budgeting work has been done for the current year by the secretary of the hospital using the previous year's figures and adding 3% for inflation. It is realized by the Hospital Authority that management information for control purposes needs to be improved, and you have been recruited to help to introduce a system of responsibility accounting.

You are required, from the information given, to:

(a) comment on the way in which the quarterly budgets have been prepared and to suggest improvements that could be introduced when preparing the budgets for 2001/2002;

(b) state what information you would like to flow from the actual against budget comparison (note that calculated figures are *not* required);

(c) state the amendments that would be needed to the current practice of budgeting and reporting to enable the report shown below to be used as a measure of the efficiency of the laundry manager.

Victorial Hospital – Laundry department
Report for quarter ended 30 September 2000

	Budget	Actual
Patients days	9 000	12 000
Weight processed (kg)	180 000	240 000
	(£)	(£)
Costs:		
Wages	8 800	12 320
Overtime premium	1 400	2 100
Detergents and other supplies	1 800	2 700
Water, water softening and heating	2 000	2 500
Maintenance	1 000	1 500
Depreciation of plant	2 000	2 000
Manager's salary	1 250	1 500
Overhead, apportioned:		
for occupancy	4 000	4 250
for administration	5 000	5 750

(15 marks)
CIMA Cost Accounting 1

17.26 Flexible budgets and the motivational role of budgets

Club Atlantic is an all-weather holiday complex providing holidays throughout the year. The fee charged to guests is fully inclusive of accommodation and all meals. However, because the holiday industry is so competitive, Club Atlantic is only able to generate profits by maintaining strict financial control of all activities.

The club's restaurant is one area where there is a constant need to monitor costs. Susan Green is the manager of the restaurant. At the beginning of each year she is given an annual budget which is then broken down into months. Each month she receives a statement monitoring actual costs against the annual budget and highlighting any variances. The statement for the month ended 31 October is reproduced below along with a list of assumptions:

Club Atlantic Restaurant Performance Statement
Month to 31 October

	Actual	Budget	Variance (over)/ under
Number of guest days	11 160	9 600	(1 560)
	(£)	(£)	(£)
Food	20 500	20 160	(340)
Cleaning materials	2 232	1 920	(312)
Heat, light and power	2 050	2 400	350
Catering wages	8 400	7 200	(1 200)
Rent rates, insurance and depreciation	1 860	1 800	(60)
	35 042	33 480	(1 562)

Assumptions:

(a) The budget has been calculated on the basis of a 30-day calendar month with the cost of rents, insurance and depreciation being an apportionment of the fixed annual charge.

(b) The budgeted catering wages assume that:

(i) there is one member of the catering staff for every 40 guests staying at the complex;

(ii) the daily cost of a member of the catering staff is £30.

(c) All other budgeted costs are variable costs based on the number of guest days.

Task 1

Using the data above, prepare a revised performance statement using flexible budgeting. Your statement should show both the revised budget and the revised variances. Club Atlantic uses the existing budgets and performance statements to motivate its managers as well as for financial control. If manages keep expenses below budget they receive a bonus in addition to their salaries. A colleague of Susan is Brian Hilton. Brian is in charge of the swimming pool and golf course, both of which have high levels of fixed costs. Each month he manages to keep expenses below budget and in return enjoys regular bonuses. Under the current reporting system, Susan Green only rarely receives a bonus.

At a recent meeting with Club Atlantic's directors Susan Green expressed concern that the performance statement was not a valid reflection of her management of the restaurant. You are currently employed by Hall and Co., the club's auditors, and the directors of Club Atlantic have asked you to advice them whether there is any justification for Susan Green's concern.

At the meeting with the Club's directors, you were asked the following questions:

(a) Do budgets motivate managers to achieve objectives?

(b) Does motivating managers lead to improved performance?

(c) Does the current method of reporting performance motivate Susan Green and Brian Hilton to be more efficient?

Task 2

Write a *brief* letter to the directors of Club Atlantic addressing their question and justifying your answers.

Note: You should make use of the data given in this task plus your findings in Task 1.

AAT Technicians Stage

17.27 Return on investment and residual income

South Plc has two divisions, A and B, whose respective performances are under review.

Division A is currently earning a profit of £35 000 and has net assets of £150 000.

Division B currently earns a profit of £70 000 with net assets of £325 000.

South Plc has a current cost of capital of 15%.

Required:

(a) Using the information above, calculate the return on investment and residual income figures for the two divisions under review and comment on your results.

(5 marks)

(b) State which method of performance evaluation (i.e. return on investment or residual income) would be more useful when comparing divisional performance and why.

(2 marks)

(c) List three general aspects of performance measures that would be appropriate for a service sector company.

(3 marks)

ACCA Paper 1.2 – Financial Information for Management



Standard costing and variance analysis

18

In the previous chapter the major features of management accounting control systems were examined. The different types of controls used by companies were described so that the elements of management accounting control systems could be considered within the context of the overall control process. A broad approach to control was adopted and the detailed procedures of financial controls were not examined. In this chapter we shall focus on one of the detailed financial controls that are used by organizations.

We shall consider a financial control system that enables the deviations from budget to be analysed in detail, thus enabling costs to be controlled more effectively. This system of control is called standard costing. In particular, we shall examine how a standard costing system operates and how the variances are calculated and recorded. Standard costing systems are applied in standard cost centres which were described in

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- explain how a standard costing system operates;
- explain how standard costs are set;
- explain the meaning of standard hours produced;
- define basic, ideal and currently attainable standards;
- identify and describe the purposes of a standard costing system;
- calculate labour, material, overhead and sales margin variances and reconcile actual profit with budgeted profit;
- identify the causes of labour, material, overhead and sales margin variances;
- construct a departmental performance report;
- distinguish between standard variable costing and standard absorption costing;
- prepare a set of accounts for a standard costing system.

the previous chapter. You will recall that the main features of standard cost centres are that output can be measured and the input required to produce each unit of output can be specified. Therefore standard costing is generally applied to manufacturing activities and non-manufacturing activities are not incorporated within the standard costing system. In addition, the sales variances that are described in this chapter can also be applied in revenue centres.

Standard costs are predetermined costs; they are target costs that should be incurred under efficient operating conditions. They are not the same as **budgeted costs**. A budget relates to an entire activity or operation; a standard presents the same information on a per unit basis. A standard therefore provides cost expectations per unit of activity and a budget provides the cost expectation for the total activity. If the budget output for a product is for 10 000 units and the standard cost is £3 per unit, budgeted cost will be £30 000. We shall see that establishing standard costs for each unit produced enables a detailed analysis to be made of the difference between the budgeted cost and the actual cost so that costs can be controlled more effectively.

In the first part of the chapter (pages 490–512) we shall concentrate on those variances that are likely to be useful for cost control purposes. The final part describes those variances that are required for financial accounting purposes but that are not particularly useful for cost control. If your course does not relate to the disposition of variances for financial accounting purposes, or the recording of standard costs in the accounts, you can omit pages 513–526.

Operation of a standard costing system

Standard costing is most suited to an organization whose activities consist of a series of *common* or *repetitive* operations and the input required to produce each unit of output can be specified. It is therefore relevant in manufacturing companies, since the processes involved are often of a repetitive nature. Standard costing procedures can also be applied in service industries such as units within banks, where output can be measured in terms of the number of cheques or the number of loan applications processed, and there are also well-defined input–output relationships. Standard costing cannot, however, be applied to activities of a non-repetitive nature, since there is no basis for observing repetitive operations and consequently standards cannot be set.

A standard costing system can be applied to organizations that produce many different products, as long as production consists of a series of common operations. For example, if the output from a factory is the result of five common operations, it is possible to produce many different product variations from these operations. It is therefore possible that a large product range may result from a small number of common operations. Thus standard costs should be developed for repetitive operations and product standard costs are derived simply by combining the standard costs from the operations which are necessary to make the product. This process is illustrated in Exhibit 18.1.

It is assumed that the standard costs are £20, £30, £40 and £50 for each of the operations 1 to 4. The standard cost for *product* 100 is therefore £110, which consists of £20 for operation 1, plus £40 and £50 for operations 3 and 4. The standard costs for each of the other products are calculated in a similar manner. In addition, the total standard cost for the total output of each operation for the period has been calculated. For example, six items of operation number 1 have been completed, giving a total standard cost of £120 for this operation (six items at £20 each). Three items of operation 2 have been completed, giving a total standard cost of £90, and so on.

Variances allocated to responsibility centres

You can see from Exhibit 18.1 that different responsibility centres are responsible for each operation. For example, responsibility centre A is responsible for operation 1, responsibility centre B for operation 2, and so on. Consequently, there is no point in comparing the actual cost of *product* 100 with the standard cost of £110 for the purposes of control, since responsibility centres A, C and D are responsible for the variance. None of the responsibility centres is solely answerable for the variance. Cost control requires that responsibility centres be identified with the standard cost for the output achieved. Therefore if the actual costs for responsibility centre A are compared with the standard cost of £120 for the production of the six items (see first row of Exhibit 18.1), the manager of this responsibility centre will be answerable for the full amount of the variance. Only by comparing total actual costs with total standard costs *for each operation or responsibility centre* for a period can control be achieved effectively. A comparison of standard *product* costs (i.e. the columns in Exhibit 18.1) with actual costs that involves several different responsibility centres is clearly inappropriate.

Figure 18.1 provides an overview of the operation of a standard costing system. You will see that the standard costs for the actual output for a particular period are traced to the managers of responsibility centres who are responsible for the various operations. The actual costs for the same period are also charged to the responsibility centres. Standard and actual costs are compared and the variance is reported. For example, if the actual cost for the output of the six items produced in responsibility centre A during the period is £220 and the standard cost is £120 (Exhibit 18.1), a variance of £100 will be reported.

Detailed analysis of variances

The box below the first arrow in Figure 18.1 indicates that the operation of a standard costing system also enables a detailed analysis of the variances to be reported. For example, variances for each responsibility centre can be identified by each element of cost and analysed according to the price and quantity content. The accountant assists managers by pinpointing where the variances have arisen and the responsibility managers can undertake to carry out the appropriate investigations to identify the reasons for the variance. For example, the accountant might identify the reason for a direct materials variance as being excessive usage of a certain material in a particular process, but the responsibility centre manager must investigate this process and identify the reasons for the excessive usage. Such an investigation should result in appropriate remedial action being taken or, if it is found that the variance is due to a permanent change in the standard, the standard should be changed.

Actual product costs are not required

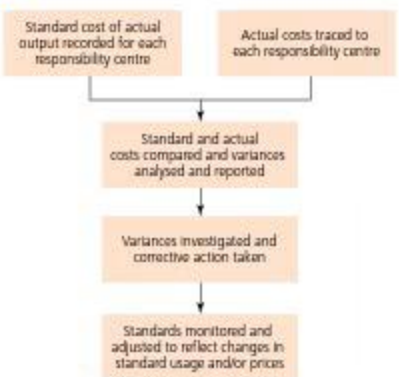
It is questionable whether the allocation of actual costs to products serves any useful purpose. Because standard costs represent *future* target costs, they are preferable to actual *past* costs for decision-making. Also, the external financial accounting regulations in most countries specify that if standard product costs provide a reasonable approximation of actual product costs, they are acceptable for inventory valuation calculations for external reporting.

EXHIBIT 18.1

Standard costs analysed by operations and products

Responsibility centre	Operation no. and standard cost		Products							Total standard cost	Actual cost
	No.	(£)	100	101	102	103	104	105	106	(£)	
A	1	20	✓	✓		✓	✓	✓	✓	120	
B	2	30		✓		✓		✓		90	
C	3	40	✓		✓		✓			120	
D	4	50	✓	✓	✓				✓	200	
Standard product cost			£110	£100	£90	£50	£60	£50	£70	530	

FIGURE 18.1 *An overview of a standard costing system*



There are therefore strong arguments for not producing actual *product* costs when a standard costing system exists, since this will lead to large clerical savings. However, it must be stressed that actual costs must be accumulated periodically for each operation or responsibility centre, so that comparisons can be made with standard costs.

Nevertheless, there will be considerably fewer responsibility centres than products, and the accumulation of actual costs is therefore much less time-consuming.

Comparisons after the event

It may be argued that there is little point in comparing actual performance with standard performance, because such comparisons can only be made after the event. Nevertheless, if people know in advance that their performance is going to be judged, they are likely to act differently from the way they would have done if they were aware that their performance was not going to be measured. Furthermore, even though it is not possible for a manager to change his or her performance after the event, an analysis of how well a person has performed in the past may indicate – both to the person concerned and his or her superior – ways of obtaining better performance in the future.

Establishing cost standards

Control over costs is best effected through action at the point where the costs are incurred. Hence the standards should be set for the quantities of material, labour and services to be consumed in performing an *operation*, rather than the complete *product* cost standards. Variances from these standards should be reported to show causes and responsibilities for deviations from standard. Product cost standards are derived by listing and adding the standard costs of operations required to produce a particular product. For example, if you refer to Exhibit 18.1 you will see that the standard cost of product 100 is £110 and is derived from the sum of the standard costs of operations 1, 3 and 4.

There are two approaches that can be used to set standard costs. First, past historical records can be used to estimate labour and material usage. Secondly, standards can be set based on **engineering studies**. With engineering studies a detailed study of each operation is undertaken based on careful specifications of materials, labour and equipment and on controlled observations of operations. If historical records are used to set standards, there is a danger that the latter will include past inefficiencies. With this approach, standards are set based on average past performance for the same or similar operations. Known excess usage of labour or materials should be eliminated or the standards may be tightened by an arbitrary percentage reduction in the quantity of resources required. The disadvantage of this method is that, unlike the engineering method, it does not focus attention on finding the best combination of resources, production methods and product quality. Nevertheless, standards derived from average historical usage do appear to be widely used in practice. (See Exhibit 18.3.)

Let us now consider how standards are established for each operation for direct labour, direct materials and overheads using the engineering studies approach. Note that the standard cost for each operation is derived from multiplying the quantity of input that should be used per unit of output (i.e. the quantity standard) by the amount that should be paid for each unit of input (i.e. the price standard).

Direct material standards

These are based on product specifications derived from an intensive study of the input *quantity* necessary for each operation. This study should establish the most suitable materials for each product, based on product design and quality policy, and also the

optimal quantity that should be used after taking into account any wastage or loss that is considered inevitable in the production process. Material quantity standards are usually recorded on a **bill of materials**. This describes and states the required quantity of materials for each operation to complete the product. A separate bill of materials is maintained for each product. The standard material product cost is then found by multiplying the standard quantities by the appropriate standard prices.

The standard *prices* are obtained from the purchasing department. The standard material prices are based on the assumption that the purchasing department has carried out a suitable search of alternative suppliers and has selected suppliers who can provide the required quantity of sound quality materials at the most competitive price. Normally, price standards take into account the advantages to be obtained by determining the most economical order quantity and quantity discounts, best method of delivery and the most favourable credit terms. However, consideration should also be given to vendor reliability with respect to material quality and meeting scheduled delivery dates. Standard prices then provide a suitable base against which actual prices paid for materials can be evaluated.

Direct labour standards

To set labour standards, activities should be analysed by the different operations. Each operation is studied and an allowed time computed, usually after carrying out a time and motion study. The normal procedure for such a study is to analyse each operation to eliminate any unnecessary elements and to determine the most efficient production method. The most efficient methods of production, equipment and operating conditions are then standardized. This is followed by time measurements that are made to determine the number of standard hours required by an average worker to complete the job. Unavoidable delays such as machine breakdowns and routine maintenance are included in the standard time. Wage rate standards are normally either a matter of company policy or the result of negotiations between management and unions. The agreed wage rates are applied to the standard time allowed to determine the standard labour cost for each operation.

Overhead standards

The procedure for establishing standard manufacturing overhead rates for a standard costing system is the same as that which is used for establishing predetermined overhead rates as described in Chapter 4. Separate rates for fixed and variable overheads are essential for planning and control. Normally the standard overhead rate will be based on a rate per direct labour hour or machine hour of input.

Fixed overheads are largely independent of changes in activity, and remain constant over wide ranges of activity in the short term. It is therefore inappropriate for short-term cost control purposes to unitize fixed overheads to derive a fixed overhead rate per unit of activity. However, in order to meet the external financial reporting stock valuation requirements, fixed manufacturing overheads must be traced to products. It is therefore necessary to unitize fixed overheads for stock valuation purposes.

The main difference with the treatment of overheads under a standard costing system as opposed to a non-standard costing system is that the product overhead cost is based on the hourly overhead rates multiplied by the *standard hours* (that is, hours which should have been used) rather than the *actual hours* used.

At this stage it is appropriate if we summarize the approach that should be used to establish cost standards. Control over costs is best effected through action at the point

where they are incurred. Hence standards should be set for labour, materials and variable overheads consumed in performing an *operation*. For stock valuation purposes it is necessary to establish *product cost* standards. Standard manufacturing product costs consist of the total of the standard costs of operations required to produce the product plus the product's standard fixed overhead cost. Note that standard costs are not normally established for non-manufacturing activities. A standard cost card should be maintained for each product and operation. It reveals the quantity of each unit of input that should be used to produce one unit of output. A typical product standard cost card is illustrated in Exhibit 18.2. In most organizations standard cost cards are now stored on a computer. Standards should be continuously reviewed, and, where significant changes in production methods or input prices occur, they should be changed in order to ensure that standards reflect current targets.

Standard hours produced

It is not possible to measure *output* in terms of units produced for a department making several different products or operations. For example, if a department produces 100 units of product X, 200 units of product Y and 300 units of product Z, it is not possible to add the production of these items together, since they are not homogeneous. This problem can be overcome by ascertaining the amount of time, working under efficient conditions, it should take to make each product. This time calculation is called **standard hours produced**. In other words, **standard hours** are an *output* measure that can act as a common denominator for adding together the production of unlike items.

Let us assume that the following standard times are established for the production of one unit of each product:

Product X 5 standard hours
Product Y 2 standard hours
Product Z 3 standard hours

This means that it should take five hours to produce one unit of product X under efficient production conditions. Similar comments apply to products Y and Z. The production for the department will be calculated in standard hours as follows:

Product	Standard time per unit produced (hours)	Actual output (units)	Standard hours produced
X	5	100	500
Y	2	200	400
Z	3	300	900
			1800

Remember that standard hours produced is an output measure, and flexible budget allowances should be based on this. In the illustration we should expect the *output* of 1800 standard hours to take 1800 direct labour hours of *input* if the department works at the prescribed level of efficiency. The department will be inefficient if 1800 standard hours of output are produced using, say, 2000 direct labour hours of input. The flexible budget allowance should therefore be based on 1800 standard hours produced to ensure that no extra allowance is given for the 200 excess hours of input. Otherwise, a manager will obtain a higher budget allowance through being inefficient.

EXHIBIT 18.2
An illustration of a standard cost card

Date standard set ..... Product: Sigma

Direct materials

Operation no.	Item code	Quantity (kg)	Standard price (£)	Department A	Department B	Department C	Department D	Totals (£)
1	5.001	5	3		£15			
2	7.003	4	4			£16		
								31

Direct labour

Operation no.	Standard hours	Standard rate (£)				
1	7	9		£63		
2	8	9			£72	
						135

Factory overhead

Department	Standard hours	Standard rate (£)				
B	7	3		£21		
C	8	4			£32	
						53
Total manufacturing cost per unit (£)						219

Types of cost standards

The determination of standard costs raises the problem of how demanding the standards should be. Should they represent ideal or faultless performance or should they represent easily attainable performance? Standards are normally classified into three broad categories:

1. basic cost standards;
2. ideal standards;
3. currently attainable standards.

Basic cost standards

Basic cost standards represent constant standards that are left unchanged over long periods. The main advantage of basic standards is that a base is provided for a comparison with actual costs through a period of years with the same standard, and efficiency trends can be established over time. When changes occur in methods of production, price levels or other relevant factors, basic standards are not very useful, since they do not represent *current* target costs. For this reason basic cost standards are seldom used.

Ideal standards

Ideal standards represent perfect performance. Ideal standard costs are the minimum costs that are possible under the most efficient operating conditions. Ideal standards are unlikely to be used in practice because they may have an adverse impact on employee motivation. Such standards constitute goals to be aimed for rather than performance that can currently be achieved.

Currently attainable standard costs

These standards represent those costs that should be incurred under efficient operating conditions. They are standards that are difficult, but not impossible, to achieve. **Attainable standards** are easier to achieve than ideal standards because allowances are made for normal spoilage, machine breakdowns and lost time. The fact that these standards represent a target that can be achieved under efficient conditions, but which is also viewed as being neither too easy to achieve nor impossible to achieve, provides the best norm to which actual costs should be compared. Attainable standards can vary in terms of the level of difficulty. For example, if tight attainable standards are set over a given time period, there might only be a 70% probability that the standard will be attained. On the other hand, looser attainable standards might be set with a probability of 90% attainment. Attainable standards are equivalent to highly achievable standards described in Chapter 16.

Attainable standards that are likely to be achieved are preferable for planning and budgeting. It is preferable to prepare the master budget and cash budget using these standards. Clearly, it is inappropriate to use standards that may not be achieved for planning purposes. Hence attainable standards that are likely to be achieved lead to economies, since they can be used for both *planning* and *control*. However, easily attainable standards are unlikely to provide a challenging target that will motivate higher levels of efficiency.

For an indication of the types of cost standards that companies actually use you should refer to Exhibit 18.3.

Purposes of standard costing

Standard costing systems are widely used because they provide cost information for many different purposes such as the following.

- Providing a prediction of future costs that can be used for *decision-making purposes*. Standard costs can be derived from either traditional or activity-based costing systems. Because standard costs represent *future* target costs based on the elimination of avoidable inefficiencies they are preferable to estimates based on adjusted past costs which may incorporate inefficiencies. For example, in markets where competitive prices do not exist products may be priced on a bid basis. In these situations standard costs provide more appropriate information because efficient competitors will seek to eliminate avoidable costs. It is therefore unwise to assume that inefficiencies are recoverable within the bid price.
- Providing a *challenging target* which individuals are motivated to achieve. For example research evidence suggests that the existence of a defined quantitative goal or target is likely to motivate higher levels of performance than would be achieved if no such target was set.
- Assisting in *setting budgets* and evaluating managerial performance. Standard costs are particularly valuable for budgeting because a reliable and convenient source of

EXHIBIT 18.3
Surveys of company practice

Since its introduction in the early 1900s standard costing has flourished and is now one of the most widely used management accounting techniques. Three independently conducted surveys of USA practice indicate highly consistent figures in terms of adopting standard costing systems. Cress and Pettijohn (1985) and Schwarzbach (1985) report an 85% adoption rate, while Cornick *et al.* (1988), found that 86% of the surveyed firms used a standard costing system. A Japanese survey by Scarborough *et al.* (1991) reported a 65% adoption rate. Surveys of UK companies by Drury *et al.* (1993) and New Zealand companies by Guilding *et al.* (1998) report adoption rates of 76% and 73% respectively.

In relation to the methods to set labour and material standards Drury *et al.* reported the following usage rates:

	Extent of use (%)				
	Never	Rarely	Sometimes	Often	Always
Standards based on design/ engineering studies	18	11	19	31	21
Observations based on trial runs	18	16	36	25	5
Work study techniques	21	18	19	21	21
Average of historic usage	22	11	23	35	9

In the USA Lauderman and Schaeberle (1983) reported that 43% of the respondents used average historic usage, 67% used engineering studies, 11% used trial runs under controlled conditions and 15% used other methods. The results add up to more than 100% because some companies used more than one method.

Drury *et al.* also reported that the following types of standards were employed:

Maximum efficiency standards	5%
Achievable but difficult to attain standards	44%
Average past performance standards	46%
Other	5%

data is provided for converting budgeted production into physical and monetary resource requirements. Budgetary preparation time is considerably reduced if standard costs are available because the standard costs of operations and products can be readily built up into total costs of any budgeted volume and product mix.

- Acting as a *control device* by highlighting those activities which do not conform to plan and thus alerting managers to those situations that may be 'out of control' and in need of corrective action. With a standard costing system variances are analysed in great detail such as by element of cost, and price and quantity elements. Useful feedback is therefore provided in pinpointing the areas where variances have arisen.
- Simplifying the task of tracing costs to products for *profit measurement and inventory valuation* purposes. Besides preparing annual financial accounting profit statements most organizations also prepare monthly internal profit statements. If actual costs are used a considerable amount of time is required in tracking costs so that monthly costs can be allocated between cost of sales and

inventories. A data processing system is required which can track monthly costs in a resource-efficient manner. Standard costing systems meet this requirement You will see from Figure 18.2 that product costs are maintained at standard cost. Inventories and cost of goods sold are recorded at standard cost and a conversion to actual cost is made by writing off all variances arising during the period as a period cost. Note that the variances from standard cost are extracted by comparing actual with standard costs at the responsibility centre level, and not at the product level, so that actual costs are not assigned to individual products.

Variance analysis

It is possible to compute variances simply by committing to memory a series of variance formulae. If you adopt this approach, however, it will not help you to understand what a variance is intended to depict and what the relevant variables represent. In our discussion of each variance we shall therefore concentrate on the fundamental meaning of the variance, so that you can logically deduce the variance formulae as we go along.

All of the variances presented in this chapter are illustrated from the information contained in Example 18.1 on page 501. Note that the level of detail presented is highly simplified. A truly realistic situation would involve many products, operations and responsibility centres but would not give any further insights into the basic concepts or procedures.

Figure 18.3 shows the breakdown of the profit variance (the difference between budgeted and actual profit) into the component cost and revenue variances that can be calculated for a standard variable costing system. We shall now calculate the variances set out in Figure 18.3 using the data presented in Example 18.1.

Material variances

The costs of the materials which are used in a manufactured product are determined by two basic factors: the price paid for the materials, and the quantity of materials used in production. This gives rise to the possibility that the actual cost will differ from the standard cost because the *actual quantity* of materials used will be different from the *standard quantity* and/or that the *actual price* paid will be different from the *standard price*. We can therefore calculate a material usage and a material price variance.

Material price variances

The starting point for calculating this variance is simply to compare the standard price per unit of materials with the actual price per unit. You should now read Example 18.1. You will see that the standard price for material A is £10 per kg, but the actual price paid was £11 per kg. The price variance is £1 per kg. This is of little consequence if the excess purchase price has been paid only for a small number of units or purchases. But the consequences are important if the excess purchase price has been paid for a large number of units, since the effect of the variance will be greater.

FIGURE 18.2 *Standard costs for inventory valuation and profit measurement*

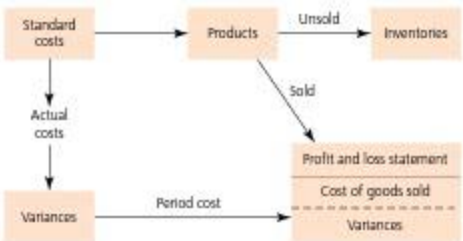
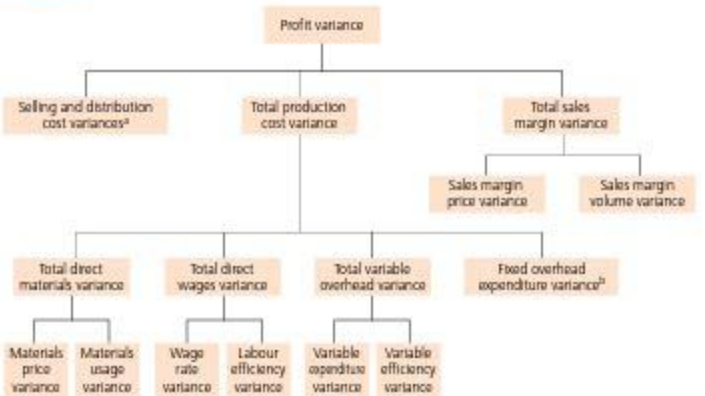


FIGURE 18.3 *Variance analysis for a variable costing system*



[a]Selling and distribution cost variances are not presented in this chapter. If activities are of a repetitive nature, standards can be established and variances can be calculated in a similar manner to production cost variances. If standards cannot be established, costs should be controlled by comparing budgeted and actual costs.

[b]With an absorption costing system, the summary of fixed overhead variances presented in Exhibit 18.6 would replace this box.

EXAMPLE 18.1

Alpha manufacturing company produces a single product, which is known as sigma. The product requires a single operation, and the standard cost for this operation is presented in the following standard cost card:

Standard cost card for product sigma	(£)
Direct materials:	
2 kg of A at £10 per kg	20.00
1 kg of B at £15 per kg	15.00
Direct labour (3 hours at £9 per hour)	27.00
Variable overhead (3 hours at £2 per direct labour hour)	6.00
Total standard variable cost	68.00
Standard contribution margin	20.00
Standard selling price	88.00

Alpha Ltd plan to produce 10 000 units of sigma in the month of April, and the budgeted costs based on the information contained in the standard cost card are as follows:

Budget based on the above standard costs and an output of 10 000 units	(£)	(£)	(£)
Sales (10 000 units of sigma at £88 per unit)			880 000
Direct materials:			
A: 20 000 kg at £10 per kg	200 000		
B: 10 000 kg at £15 per kg	150 000	350 000	
Direct labour (30 000 hours at £9 per hour)		270 000	
Variable overheads (30 000 hours at £2 per direct labour hour)		60 000	680 000
Budgeted contribution			200 000
Fixed overheads			120 000
Budgeted profit			80 000

Annual budgeted fixed overheads are £1 440 000 and are assumed to be incurred evenly throughout the year. The company uses a variable costing system for internal profit measurement purposes.

The actual results for April are:

	(£)	(£)
Sales (9000 units at £90)		810 000
Direct materials:		
A: 19 000 kg at £11 per kg	209 000	
B: 10 100 kg at £14 per kg	141 400	
Direct labour (28 500 hours at £9.60 per hour)	273 600	
Variable overheads	52 000	676 000
Contribution		134 000
Fixed overheads		116 000
Profit		18 000

Manufacturing overheads are charged to production on the basis of direct labour hours. Actual production and sales for the period were 9000 units.

The difference between the standard material price and the actual price per unit should therefore be multiplied by the quantity of materials purchased. For material A the price variance is £1 per unit; but since 19 000 kg were purchased, the excess price was paid out 19 000 times. Hence the total material price variance is £19 000 adverse. The formula for the material price variance now follows logically:

the **material price variance** is equal to the difference between the standard price (SP) and the actual price (AP) per unit of materials multiplied by the quantity of materials purchased (QP):

$$(SP - AP) \times QP$$

Now refer to material B in Example 18.1. The standard price is £15, compared with an actual price of £14 giving a £1 saving per kg. As 10 100 kg were purchased, the total price variance will be £10 100 (10 100kg at £1). The variance for material B is favourable and that for material A is adverse. The normal procedure is to present the amount of the variances followed by symbols A or F to indicate either adverse or favourable variances.

Possible causes

It is incorrect to assume that the material price variance will always indicate the efficiency of the purchasing department. Actual prices may exceed standard prices because of a change in market conditions that causes a general price increase for the type of materials used. The price variance might therefore be beyond the control of the purchasing department. Alternatively, an adverse price variance may reflect a failure by the purchasing department to seek the most advantageous sources of supply. A favourable price variance might be due to the purchase of inferior quality materials, which may lead to inferior product quality or more wastage. For example, the price variance for material B is favourable, but we shall see in the next section that this is offset by excess usage. If the reason for this excess usage is the purchase of inferior quality materials then the material usage variance should be charged to the purchasing department.

It is also possible that another department may be responsible for all or part of the price variance. For example, a shortage of materials resulting from bad inventory control may necessitate an emergency purchase being made at short notice. The supplier may incur additional handling and freight charges on special rush orders, and may therefore charge a higher price for the materials. In this situation the price variance will be the responsibility of the stores department and not the purchasing department.

Calculation on quantity purchased or quantity used

We have noted that the price variance may be due to a variety of causes, some of which will be beyond a company's control, but others of which may be due to inefficiencies. It is therefore important that variances be reported as quickly as possible so that any inefficiencies can be identified and remedial action taken. A problem occurs, however, with material purchases in that the time of purchase and the time of usage may not be the same: materials may be purchased in one period and used in a subsequent period. For example, if 10 000 units of a material are purchased in period 1 at a

price of £1 per unit over standard and 2000 units are used in each of periods 1 to 5, the following alternatives are available for calculating the price variance:

1. The full amount of the price variance of £10 000 is reported in *period 1* with quantity being defined as the *quantity purchased*.
2. The price variance is calculated with quantity being defined as the *quantity used*. The unit price variance of £1 is multiplied by the quantity used (i.e. 2000 units), which means that a price variance of £2000 will be reported for each of *periods 1 to 5*.

Method 1 is recommended, because the price variance can be reported in the period in which it is incurred, and reporting of the total variance is not delayed until months later when the materials are used. Also, adopting this approach enables corrective action to be taken earlier. For the sake of simplicity we shall assume in Example 18.1 that the actual purchases are identical with the actual usage.

Material usage variance

The starting point for calculating this quantity variance is simply to compare the standard quantity that should have been used with the actual quantity which has been used. Refer again to Example 18.1. You will see that the standard usage for the production of one unit of sigma is 2 kg for material A. As 9000 units of sigma are produced, 18 000 kg of material A should have been used; however, 19 000 kg are actually used, which means there has been an excess usage of 1000 kg.

The importance of this excess usage depends on the price of the materials. For example, if the price is £0.01 per kg then an excess usage of 1000 kg will not be very significant, but if the price is £10 per unit then an excess usage of 1000 kg will be very significant. It follows that to assess the importance of the excess usage, the variance should be expressed in monetary terms.

Calculation based on standard price or actual price

Should the standard material price per kg or the actual material price per kg be used to calculate the variance? The answer is the standard price. If the *actual* material price is used, the usage variance will be affected by the efficiency of the purchasing department, since any excess purchase price will be assigned to the excess usage. It is therefore necessary to remove the price effects from the usage variance calculation, and this is achieved by valuing the variance at the standard price. Hence the 1000 kg excess usage of material A is multiplied by the standard price of £10 per unit, which gives an adverse usage variance of £10 000. The formula for the variance is

the **material usage variance** is equal to the difference between the standard quantity (SQ) required for actual production and the actual quantity (AQ) used multiplied by the standard material price (SP):

$$(SQ - AQ) \times SP$$

For material B you will see from Example 18.1 that the standard quantity is 9000 kg (9000 units × 1 kg), but 10 100 kg have been used. The excess usage of 1100 kg is multiplied by the standard price of £15 per kg, which gives an adverse variance of

£16 500. Note that the principles of flexible budgeting described in the previous chapter also apply here, with *standard quantity being based on actual production and not budgeted production.* This ensures that a manager is evaluated under the conditions in which he or she actually worked and not those envisaged at the time the budget was prepared.

Possible causes

The material usage variance is normally controllable by the manager of the appropriate production responsibility centre. Common causes of material usage variances include the careless handling of materials by production personnel, the purchase of inferior quality materials, pilferage, changes in quality control requirements, or changes in methods of production. Separate material usage variances should be calculated for each type of material used and allocated to each responsibility centre.

Total material variance

From Figure 18.3 you will see that this variance is the total variance before it is analysed into the price and usage elements. The formula for the variance is:

the **total material variance** is the difference between the standard material cost (SC) for the actual production and the actual cost (AC):

$$SC - AC$$

For material A the standard material cost is £20 per unit (see Example 18.1), giving a total standard material cost of £180 000 (9000 units × £20). The actual cost is £209 000, and therefore the variance is £29 000 adverse. The price variance of £19 000 plus the usage variance of £10 000 agrees with the total material variance. Similarly, the total material variance for material B is £6400, consisting of a favourable price variance of £10 100 and an adverse usage variance of £16 500.

Note that if the price variance is calculated on the actual quantity *purchased* instead of the actual quantity *used*, the price variance plus the usage variance will agree with the total variance only when the quantity purchased is equal to the quantity which is used in the particular accounting period. Reconciling the price and usage variance with the total variance is merely a reconciliation exercise, and you should not be concerned if reconciliation of the sub-variances with the total variance is not possible.

Labour variances

The cost of labour is determined by the price paid for labour and the quantity of labour used. Thus a price and quantity variance will also arise for labour. Unlike materials, labour cannot be stored, because the purchase and usage of labour normally takes place at the same time. Hence the actual quantity of hours *purchased* will be equal to the actual quantity of hours *used* for each period. For this reason the price variance plus the quantity variance should agree with the total labour variance.



Standard costing at Montclair Papers Division of Mohawk Forest Products

Montclair produces 1500 different products, including Forest Green Carnival. Its standard cost of $2900 per ton is derived from:

- union wage rates for labour costs ('Pattern bargaining' virtually assured comparable labour costs among the major union firms, all of which were unionized);
- standard yield rates for all manufacturing steps, based on latest performance measured against long-standing norms at the Montclair mill;
- current market prices for all purchased components;
- generally accepted industry procedures for building the 'normal' cost of scrap into the standard cost, after deducting the offset for the market value of the scrap generated.

The standards were updated annually for changes in purchase prices, process flows and yield targets. With more than 1500 products manufactured in the mill, more frequent updating was deemed unfeasible.

Manufacturing management accepted that the standard cost represented best practices of the mill and thus was an appropriate basis for monitoring monthly performance. Standard costs were also helpful to simplify calculating the month-end cost of goods sold and the ending inventory for financial statements. Updated only once a year, the standard cost was stable from month to month. Management viewed this stability as a positive feature in monitoring monthly performance against the annual plan.

Source: Shank, J. K. and Fisher, J. (1999), Target costing as a strategic tool, *Sloan Management Review*, Fall, Vol. 41 Issue 1, pp. 73–82.

Wage rate variance

This variance is calculated by comparing the standard price per hour with the actual price paid per hour. In Example 18.1 the standard wage rate per hour is £9 and the actual wage rate is £9.60 per hour, giving a wage rate variance of £0.60 per hour. To determine the importance of the variance, it is necessary to ascertain how many times the excess payment of £0.60 per hour is paid. As 28 500 labour hours are used (see Example 18.1), we multiply 28 500 hours by £0.60. This gives an adverse wage rate variance of £17 100. The formula for the wage rate variance is:

the **wage rate variance** is equal to the difference between the standard wage rate per hour (SR) and the actual wage rate (AR) multiplied by the actual number of hours worked (AH):

$$(SR - AR) \times AH$$

Note the similarity between this variance and the material price variance. Both variances multiply the difference between the standard price and the actual price paid for a unit of a resource by the actual quantity of resources used.

Possible causes

The wage rate variance may be due to a negotiated increase in wage rates not yet having been reflected in the standard wage rate. In a situation such as this the variance cannot be regarded as controllable. Unexpected overtime can also be a cause of this variance. Labour rate variances may also occur because a standard is used that represents a single average rate for a given operation performed by workers who are paid at several different rates. In this situation part of all of the variance may be due to the assignment of skilled labour to work that is normally performed by unskilled labour. The variance may then be regarded as the responsibility of the foreman, because he should have matched the appropriate grade of labour to the task at hand. However, the wage rate variance is probably the one that is least subject to control by management. In most cases the variance is due to wage rate standards not being kept in line with changes in actual wage rates, and for this reason it is not normally controllable by departmental managers.

Labour efficiency variance

The labour efficiency variance represents the quantity variance for direct labour. The quantity of labour that should be used for the actual output is expressed in terms of *standard hours produced*. In Example 18.1 the standard time for the production of one unit of sigma is 3 hours. Thus a production level of 9000 units results in an output of 27 000 standard hours. In other words, working at the prescribed level of efficiency, it should take 27 000 hours to produce 9000 units. However, 28 500 direct labour hours are actually required to produce this output, which means that 1500 excess direct labour hours are used. We multiply the excess direct labour hours by the *standard* wage rate to calculate the variance. This gives an adverse variance of £13 500. The formula for calculating the labour efficiency variance is:

the **labour efficiency variance** is equal to the difference between the standard labour hours for actual production (SH) and the actual labour hours worked (AH) during the period multiplied by the standard wage rate per hour (SR):

$$(SH - AH) \times SR$$

This variance is similar to the material usage variance. Both variances multiply the difference between the standard quantity and actual quantity of resources consumed by the standard price.

Possible causes

The labour efficiency variance is normally controllable by the manager of the appropriate production responsibility centre and may be due to a variety of reasons. For example, the use of inferior quality materials, different grades of labour, failure to maintain machinery in proper condition, the introduction of new equipment or tools and changes in the production processes will all affect the efficiency of labour. An efficiency variance may not always be controllable by the production foreman; it may be due, for example, to poor production scheduling by the planning department, or to a change in quality control standards.

Total labour variance

From Figure 18.3 you will see that this variance represents the total variance before analysis into the price and quantity elements. The formula for the variance is:

the **total labour variance** is the difference between the standard labour cost (SC) for the actual production and the actual labour cost (AC):

$$SC - AC$$

In Example 18.1 the actual production was 9000 units, and, with a standard labour cost of £27 per unit, the standard cost is £243 000. The actual cost is £273 600, which gives an adverse variance of £30 600. This consists of a wage rate variance of £17 100 and a labour efficiency variance of £13 500.

Variable overhead variances

A total variable overhead variance is calculated in the same way as the total direct labour and material variances. In Example 18.1 the output is 9000 units and the standard variable overhead cost is £6 *per unit* produced. The standard cost of production for variable overheads is thus £54 000. The actual variable overheads incurred are £52 000, giving a favourable variance of £2000. The formula for the variance is:

the **total variable overhead variance** is the difference between the standard variable overheads charged to production (SC) and the actual variable overheads incurred (AC):

$$SC - AC$$

Where variable overheads vary with direct labour or machine hours of *input* the total variable overhead variance will be due to one or both of the following:

1. A *price* variance arising from actual expenditure being different from budgeted expenditure.
2. A *quantity* variance arising from actual direct labour or machine hours of input being different from the hours of input, which *should* have been used.

These reasons give rise to the two sub-variances, which are shown in Figure 18.3: the variable overhead expenditure variance and the variable overhead efficiency variance.

Variable overhead expenditure variance

To compare the actual overhead expenditure with the budgeted expenditure, it is necessary to flex the budget. Because it is assumed in Example 18.1 that variable overheads will vary with direct labour hours of *input* the budget is flexed on this basis. Actual variable overhead expenditure is £52 000, resulting from 28 500 direct labour hours of input. For this level of activity variable overheads of £57 000, which consist of 28 500 input hours at £2 per hour, should have been spent. Spending was £5000 less than it should have been, and the result is a favourable variance.

If we compare the budgeted and the actual overhead costs for 28 500 direct labour hours of input, we shall ensure that any efficiency content is removed from the variance. This means that any difference must be due to actual variable overhead spending being different from the budgeted variable overhead spending. The formula for the variance is:

the **variable overhead expenditure variance** is equal to the difference between the budgeted flexed variable overheads (BFVO) for the actual direct labour hours of input and the actual variable overhead costs incurred (AVO):

$$\text{BFVO} - \text{AVO}$$

Possible causes

Variable overhead represents the aggregation of a large number of individual items, such as indirect labour, indirect materials, electricity, maintenance and so on. The variable overhead variance can arise because the prices of individual items have changed. Alternatively, the variance can also be affected by how efficiently the individual variable overhead items are used. Waste or inefficiency, such as using more kilowatt-hours of power than should have been used will increase the cost of power and, thus, the total cost of variable overhead. The variable overhead expenditure on its own is therefore not very informative. Any meaningful analysis of this variance requires a comparison of the actual expenditure for each individual item of variable overhead expenditure against the budget. If you refer to the performance report presented in Exhibit 18.8 on pages 519–20, you can see how the £5000 variable overhead expenditure variance can be analysed by individual items of expenditure. Control should be exercised by focusing on the individual line items of the expenditure variances and not the total variance.

Variable overhead efficiency variance

In Example 18.1 it is assumed that variable overheads vary with direct labour hours of input. The variable overhead efficiency variance arises because 28 500 direct labour hours of input were required to produce 9000 units. Working at the prescribed level of efficiency, it should take 27 000 hours to produce 9000 units of output. Therefore an extra 1500 direct labour hours of input were required. Because variable overheads are assumed to vary with direct labour hours of input, an additional £3000 (1500 hours at £2) variable overheads will be incurred. The formula for the variance is:

the **variable overhead efficiency variance** is the difference between the standard hours of output (SH) and the actual hours of input (AH) for the period multiplied by the standard variable overhead rate (SR):

$$(\text{SH} - \text{AH}) \times \text{SR}$$

You should note that if it is assumed that variable overheads vary with direct labour hours of input, this variance is identical to the labour efficiency variance. Consequently, the reasons for the variance are the same as those described previously for the labour efficiency variance. If you refer again to Figure 18.3, you will see that the variable overhead expenditure variance (£5000 favourable) plus the variable efficiency variance (£3000 adverse) add up to the total variable overhead variance of £2000 favourable.

Similarities between materials, labour and overhead variances

So far, we have calculated price and quantity variances for direct material, direct labour and variable overheads. You will have noted the similarities between the computations of the three quantity and price variances. For example, we calculated the quantity variances (i.e. material usage, labour efficiency and variable overhead efficiency variances) by multiplying the difference between the standard quantity (SQ) of resources consumed for the actual production and the actual quantity (AQ) of resources consumed by the standard price (SP) per unit of the resource. Thus, the three quantity variances can be formulated as

$$(SQ - AQ) \times SP$$

Note that the standard quantity is derived from determining the quantity that should be used *for the actual production* for the period so that the principles of flexible budgeting are applied.

The price variances (i.e. material price, wage rate and variable overhead expenditure variances) were calculated by multiplying the difference between the standard price (SP) and the actual price (AP) per unit of a resource by the actual quantity (AQ) of resources acquired/used. The price variances can be formulated as

$$(SP - AP) \times AQ$$

This can be re-expressed as

$$(AQ \times SP) - (AQ \times AP)$$

Note that the first term in this formula (with AQ representing actual hours) is equivalent to the budgeted flexed variable overheads that we used to calculate the variable overhead expenditure variance. The last term represents the actual cost of the resources consumed.

We can therefore calculate all the price and quantity variances illustrated so far in this chapter by applying the formulae outlined above.

Fixed overhead expenditure or spending variance

The final variance shown in Figure 18.3 is the fixed overhead expenditure variance. With a variable costing system, fixed manufacturing overheads are not unitized and allocated to products. Instead, the total fixed overheads for the period are charged as an expense to the period in which they are incurred. Fixed overheads are assumed to remain unchanged in the short term in response to changes in the level of activity, but they may change in response to other factors. For example, price increases may cause expenditure on fixed overheads to increase. The fixed overhead expenditure variance therefore explains the difference between budgeted fixed overheads and the actual fixed overheads incurred. The formula for the **fixed overhead expenditure variance** is the difference between the budgeted fixed overheads (BFO) and the actual fixed overhead (AFO) spending:

$$BFO - AFO$$

In Example 18.1 budgeted fixed overhead expenditure is £120 000 and actual fixed overhead spending £116 000. Therefore the fixed overhead expenditure variance is £4000. Whenever the actual fixed overheads are less than the budgeted fixed overheads, the variance will be favourable. The total of the fixed overhead expenditure variance on its own is not particularly informative. Any meaningful analysis of this variance requires a comparison of the actual expenditure for each individual item of fixed overhead expenditure against the budget. The difference may be due to a variety of causes, such as changes in salaries paid to supervisors, or the appointment of additional supervisors. Only by comparing individual items of expenditure and ascertaining the reasons for the variances, can one determine whether the variance is controllable or uncontrollable. Generally, this variance is likely to be uncontrollable in the short term.

Sales variances

Sales variances can be used to analyse the performance of the sales function or revenue centres on broadly similar terms to those for manufacturing costs. The most significant feature of sales variance calculations is that they are calculated in terms of profit or contribution margins rather than sales values. Consider Example 18.2.

You will see that when the variances are calculated on the basis of sales *value*, it is necessary to compare the budgeted sales *value* of £110 000 with the actual sales of £120 000. This gives a favourable variance of £10 000. This calculation, however, ignores the impact of the sales effort on profit. The budgeted profit contribution is £40 000, which consists of 10 000 units at £4 per unit, but the actual impact of the sales effort in terms of profit margins indicates a profit contribution of £36 000, which consists of 12 000 units at £3 per unit, indicating an adverse variance of £4000. If we examine Example 18.2, we can see that the selling prices have been reduced, and that this has led not only to an increase in the total sales revenue but also to a reduction in total profits. The objective of the selling function is to influence favourably total profits. Thus a more meaningful performance measure will be obtained by comparing the results of the sales function in terms of profit or contribution margins rather than sales revenues.

Note that with a standard absorption costing system, *profit* margins are used (selling price less total unit manufacturing cost), whereas with a standard variable costing system, *contribution* margins (selling price less unit manufacturing variable cost) are used to calculate the variances.

Let us now calculate the sales variances for a standard variable costing system from the information contained in Example 18.1.

Total sales margin variance

Where a variable costing approach is adopted, the total sales *margin* variance seeks to identify the influence of the sales function on the difference between budget and actual profit contribution. In Example 18.1 the budgeted profit contribution is £200 000, which consists of budgeted sales of 10 000 units at a contribution of £20 per unit. This is compared with the contribution from the actual sales volume of 9000 units. Because the sales function is responsible for the sales volume and the unit selling price, but not the unit manufacturing costs, the standard cost of sales and not the actual cost of sales

EXAMPLE 18.2

The budgeted sales for a company are £110 000 consisting of 10 000 units at £11 per unit. The standard cost per unit is £7. Actual sales are £120 000 (12 000 units at £10 per unit) and the actual cost per unit is £7.

is deducted from the actual sales revenue. The calculation of *actual* contribution for ascertaining the total sales margin variance will therefore be as follows:

	(£)
Actual sales revenue (9000 units at £90)	810 000
Standard variable cost of sales for actual sales volume (9000 units at £68)	612 000
Actual profit contribution margin	198 000

To calculate the total sales margin variance, we compare the budgeted contribution of £200 000 with the actual contribution of £198 000. This gives an adverse variance of £2000 because the actual contribution is less that the budgeted profit contribution.

The formula for calculating the variance is as follows:

the **total sales margin variance** is the difference between the actual contribution (AC) and the budgeted contribution (BC) (both based on standard unit costs):

$$AC - BC$$

Using the standard cost to calculate both the budgeted and the actual contribution ensures that the production variances do not distort the calculation of the sales variances. The effect of using standard costs throughout the contribution margin calculations means that the sales variances arise because of changes in those variables controlled by the sales function (i.e. selling prices and sales quantity). Consequently, Figure 18.3 indicates that it is possible to analyse the total sales margin variance into two sub-variances – a sales margin price variance and a sales margin volume variance.

Sales margin price variance

In Example 18.1 the actual selling price is £90 but the budgeted selling price is £88. With a standard unit variable cost of £68, the change in selling price has led to an increase in the contribution margin from £20 per unit to £22 per unit. Because the actual sales volume is 9000 units, the increase in the selling price means that an increased contribution margin is obtained 9000 times, giving a favourable sales margin price variance of £18 000. The formula for calculating the variance is:

the **sales margin price variance** is the difference between the actual contribution margin (AM) and the standard margin (SM) (both based on standard unit costs) multiplied by the actual sales volume (AV):

$$(AM - SM) \times AV$$

Sales margin volume variance

To ascertain the effect of changes in the sales volume on the difference between the budgeted and the actual contribution, we must compare the budgeted sales volume with the actual sales volume. You will see from Example 18.1 that the budgeted sales are 10 000 units but the actual sales are 9000 units, and to enable us to determine the impact of this reduction in sales volume on profit, we must multiply the 1000 units by the standard contribution margin of £20. This gives an adverse variance of £20 000.

The use of the standard margin (standard selling price less standard cost) ensures that the standard selling price is used in the calculation, and the volume variance will not be affected by any *changes* in the actual selling prices. The formula for calculating the variance is:

the **sales margin volume variance** is the difference between the actual sales volume (AV) and the budgeted volume (BV) multiplied by the standard contribution margin (SM):

$$(AV - BV) \times SM$$

Reconciling budgeted profit and actual profit

Top management will be interested in the reason for the actual profit being different from the budgeted profit. By adding the favourable production and sales variances to the budgeted profit and deducting the adverse variances, the reconciliation of budgeted and actual profit shown in Exhibit 18.4 can be presented in respect of Example 18.1.

Example 18.1 assumes that Alpha Ltd produces a single product consisting of a single operation and that the activities are performed by one responsibility centre. In practice, most companies make many products, which require operations to be carried out in different responsibility centres. A reconciliation statement such as that presented in Exhibit 18.4 will therefore normally represent a summary of the variances for many responsibility centres. The reconciliation statement thus represents a broad picture to top management that explains the major reasons for any difference between the budgeted and actual profits.

Standard absorption costing

The external financial accounting regulations in most countries require that companies should value inventories at full absorption manufacturing cost. The effect of this is that fixed overheads should be allocated to products and included in the closing inventory valuations. With the variable costing system, fixed overheads are not allocated to products. Instead, the total fixed costs are charged as an expense to the period in which they are incurred. (For a discussion of the differences between variable and absorption costing systems you should refer back to Chapter 8.) With an absorption costing system, an additional fixed overhead variance is calculated. This variance is called a **volume variance**. In addition, the sales margin variances must be expressed in unit *profit* margins instead of *contribution* margins. These variances are not particularly useful for control purposes. If your course does not relate to the disposition of variances to meet financial accounting requirements (i.e. standard absorption costing), you can omit pages 513–7.

EXHIBIT 18.4

Reconciliation of budgeted and actual profits for a standard variable costing system

	(£)	(£)	(£)
Budgeted net profit			80 000
Sales variances:			
Sales margin price	18 000F		
Sales margin volume	20 000A	2 000A	
Direct cost variances:			
Material: Price	8 900A		
Usage	26 500A	35 400A	
Labour: Rate	17 100A		
Efficiency	13 500A	30 600A	
Manufacturing overhead variances:			
Fixed overhead expenditure	4 000F		
Variable overhead expenditure	5 000F		
Variable overhead efficiency	3 000A	6 000F	62 000A
Actual profit			18 000

With a standard absorption costing system, predetermined fixed overhead rates are established by dividing annual budgeted fixed overheads by the budgeted annual level of activity. We shall assume that in respect of Example 18.1, budgeted annual fixed overheads are £1 440 000 (£120 000 per month) and budgeted annual activity is 120 000 units (10 000 units per month). The fixed overhead rate per unit of output is calculated as follows:

$$\frac{\text{budgeted fixed overheads (£1 440 000)}}{\text{budgeted activity (120 000 units)}} = \text{£12 per unit of sigma produced}$$

We have noted earlier in this chapter that in most situations more than one product will be produced. Where different products are produced, units of output should be converted to standard hours. In Example 18.1 the output of one unit of sigma requires 3 direct labour hours. Therefore, the budgeted output in standard hours is 360 000 hours (120 000 × 3 hours). The fixed overhead rate per standard hour of output is

$$\frac{\text{budgeted fixed overheads (£1 440 000)}}{\text{budgeted standard hours (360 000)}} = \text{£4 per standard hour}$$

By multiplying the number of hours required to produce one unit of Sigma by £4 per hour, we also get a fixed overhead allocation of £12 for one unit of Sigma (3 hours × £4). For the remainder of this chapter output will be measured in terms of standard hours produced.

We shall assume that production is expected to occur evenly throughout the year. Monthly budgeted production output is therefore 10 000 units, or 30 000 standard direct labour hours. At the planning stage an input of 30 000 direct labour hours (10 000 × 3 hours) will also be planned as the company will budget at the level of efficiency specified in the calculation of the product standard cost. Thus the **budgeted hours of input** and the **budgeted hours of output** (i.e. the standard hours produced) will be the same at the planning stage. In contrast, the *actual* hours of input may differ from the *actual* standard hours of output. In Example 18.1 the actual direct labour hours of input are 28 500, and 27 000 standard hours were actually produced.

With an absorption costing system, fixed overheads of £108 000 (27 000 standard hours of output at a standard rate of £4 per hour) will have been charged to products

for the month of April. Actual fixed overhead expenditure was £116 000. Therefore, £8000 has not been allocated to products. In other words, there has been an under-recovery of fixed overheads. Where the fixed overheads allocated to products exceeds the overhead incurred, there will be an over-recovery of fixed overheads. The under- or over-recovery of fixed overheads represents the total fixed overhead variance for the period. The total fixed overhead variance is calculated using a formula similar to those for the total direct labour and total direct materials variances:

the **total fixed overhead variance** is the difference between the standard fixed overhead charged to production (SC) and the actual fixed overhead incurred (AC):

$$\text{SC (£108 000)} - \text{AC (£116 000)} = \text{£8000A}$$

Note that the standard cost for the actual production can be calculated by measuring production in standard hours of output (27 000 hours × £4 per hour) or units of output (9000 units × £12 per unit).

The under- or over-recovery of fixed overheads (i.e. the fixed overhead variance) arises because the fixed overhead rate is calculated by dividing *budgeted* fixed overheads by *budgeted* output. If actual output or fixed overhead expenditure differs from budget, an under- or over-recovery of fixed overheads will arise. In other words, the under- or over-recovery may be due to the following:

1. A fixed overhead expenditure variance of £4000 arising from actual *expenditure* (£116 000) being different from budgeted *expenditure* (£120 000).
2. A fixed overhead volume variance arising from actual *production* differing from budgeted production.

The fixed overhead expenditure variance also occurs with a variable costing system. The favourable variance of £4000 was explained earlier in this chapter. The volume variance arises only when inventories are valued on an absorption costing basis.

Volume variance

This variance seeks to identify the portion of the total fixed overhead variance that is due to actual production being different from budgeted production. In Example 18.1 the standard fixed overhead rate of £4 per hour is calculated on the basis of a normal activity of 30 000 standard hours per month. Only when actual standard hours produced are 30 000 will the budgeted monthly fixed overheads of £120 000 be exactly recovered. Actual output, however, is only 27 000 standard hours. The fact that the actual production is 3000 standard hours less than the budgeted output hours will lead to a failure to recover £12 000 fixed overhead (3000 hours at £4 fixed overhead rate per hour). The formula for the variance is:

the **volume variance** is the difference between actual production (AP) and budgeted production (BP) for a period multiplied by the standard fixed overhead rate (SR):

$$(\text{AP} - \text{BP}) \times \text{SR}$$

The volume variance reflects the fact that fixed overheads do not fluctuate in relation to output in the short term. Whenever actual production is less than budgeted production, the fixed overhead charged to production will be less than the budgeted

cost, and the volume variance will be adverse. Conversely, if the actual production is greater than the budgeted production, the volume variance will be favourable.

Possible causes

Changes in production volume from the amount budgeted may be caused by shifts in demand for products, labour disputes, material shortages, poor production scheduling, machine breakdowns, labour efficiency and poor production quality. Some of these factors may be controllable by production or sales management, while others may not.

When the adverse volume variance of £12 000 is netted with the favourable expenditure variance of £4000, the result is equal to the total fixed overhead adverse variance of £8000. It is also possible to analyse the volume variance into two further sub-variances – the volume efficiency variance and the capacity variance.

Volume efficiency variance

If we wish to identify the reasons for the volume variance, we may ask why the actual production was different from the budgeted production. One possible reason may be that the labour force worked at a different level of efficiency from that anticipated in the budget.

The actual number of direct labour hours of input was 28 500. Hence one would have expected 28 500 hours of output (i.e. standard hours produced) from this input, but only 27 000 standard hours were actually produced. Thus one reason for the failure to meet the budgeted output was that output in standard hours was 1500 hours less than it should have been. If the labour force had worked at the prescribed level of efficiency, an additional 1500 standard hours would have been produced, and this would have led to a total of £6000 (£1500 hours at £4 per standard hour) fixed overheads being absorbed. The inefficiency of labour is therefore one of the reasons why the actual production was less than the budgeted production, and this gives an adverse variance of £6000. The formula for the variance is:

the **volume efficiency variance** is the difference between the standard hours of output (SH) and the actual hours of input (AH) for the period multiplied by the standard fixed overhead rate (SR):

$$(SH - AH) \times SR$$

You may have noted that the physical content of this variance is a measure of labour efficiency and is identical with the labour efficiency variance. Consequently, the reasons for this variance will be identical with those previously described for the labour efficiency variance.

Volume capacity variance

This variance indicates the second reason why the actual production might be different from the budgeted production. The budget is based on the assumption that

the direct labour hours of input will be 30 000 hours, but the actual hours of input are 28 500 hours. The difference of 1500 hours reflects the fact that the company has failed to utilize the planned capacity. If we assume that the 1500 hours would have been worked at the prescribed level of efficiency, an additional 1500 standard hours could have been produced and an additional £6000 fixed overhead could have been absorbed. Hence the capacity variance is £6000 adverse.

Whereas the volume efficiency variance indicated a failure to utilize capacity *efficiently*, the volume capacity variance indicates a failure to utilize capacity *at all*. The formula is:

the **volume capacity variance** is the difference between the actual hours of input (AH) and the budgeted hours of input (BH) for the period multiplied by the standard fixed overhead rate (SR):

$$(AH - BH) \times SR$$

A failure to achieve the budgeted capacity may be for a variety of reasons. Machine breakdowns, material shortages, poor production scheduling, labour disputes and a reduction in sales demand are all possible causes of an adverse volume capacity variance.

Summary of fixed overhead variances

The volume efficiency variance is £6000 adverse, and the volume capacity variance is also £6000 adverse. When these two variances are added together, they agree with the fixed overhead volume variance of £12 000. Exhibit 18.5 summarizes how the volume variance is analysed according to capacity and efficiency.

The actual *output* was 3000 hours less than the budget, giving an adverse volume variance. The capacity variance indicates that one reason for failing to meet the budgeted output was that 1500 hours of *capacity* were not utilized. In addition, those 28 500 hours that were utilized only led to 27 000 hours of output. An inefficient use of 1500 hours capacity therefore provides a second explanation as to why the budgeted output was not achieved. A fixed overhead rate of £4 per hour is applied to the physical quantity of the variances, so that fixed overhead variances may be presented in monetary terms. Exhibit 18.6 summarizes the variances we have calculated in this section.

Reconciliation of budgeted and actual profit for a standard absorption costing system

The reconciliation of the budgeted and actual profits is shown in Exhibit 18.7. You will see that the reconciliation statement is identical with the variable costing reconciliation statement, apart from the fact that the absorption costing statement includes the fixed overhead volume variance and values the sales margin volume variance at the standard profit margin per unit instead of the contribution per unit. If you refer back to Example 18.1 on page 501, you will see that the contribution margin for Sigma is £20 per unit sold whereas the profit margin per unit after deducting fixed overhead cost (£12 per unit) is £8.

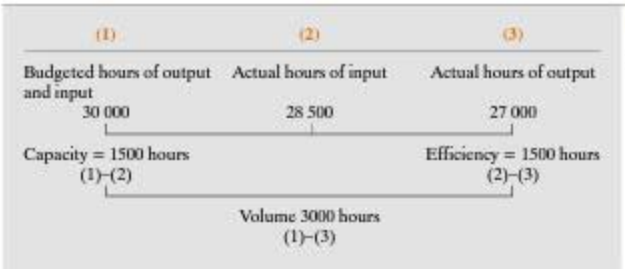


EXHIBIT 18.5
Analysis of the volume variance

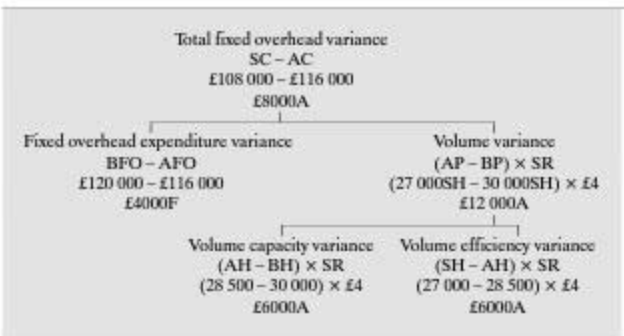


EXHIBIT 18.6
Diagram of fixed overhead variances

Multiplying the difference in budgeted and actual sales volumes of 1000 units by the standard profit margin gives a sales volume margin variance of £8000. Note that the sales margin price variance is identical for both systems.

Performance reports

The managers of responsibility centres will require a more detailed analysis of the variances to enable them to exercise control, and detailed performance reports should be prepared at monthly or weekly intervals to bring to their attention any significant variances. A typical performance report based on the information contained in Example 18.1 is presented in Exhibit 18.8. A departmental performance report should include only those items that the responsibility manager can control or influence. The material price variance and the monetary amount of the volume variance are *not* presented, since these are not considered to be within the control of the manager of the responsibility centre. However, the volume variance and the two sub-variances (capacity and

EXHIBIT 18.7

Reconciliation of budgeted and actual profit for a standard absorption costing system

	(£)	(£)	(£)	(£)
Budgeted net profit				80 000
Sales variances:				
Sales margin price		18 000F		
Sales margin volume		8 000A	10 000F	
Direct cost variances:				
Material – Price: Material A	19 000A			
Material B	10 100F	8 900A		
– Usage: Material A	10 000A			
Material B	16 500A	26 500A	35 400A	
Labour – Rate		17 100A		
Efficiency		13 500A	30 600A	
Manufacturing overhead variances:				
Fixed – Expenditure	4 000F			
Volume	12 000A	8 000A		
Variable – Expenditure	5 000F			
Efficiency	3 000A	2 000F	6 000A	62 000A
Actual profit				18 000

efficiency) are restated in non-monetary terms in Exhibit 18.8. You can see that these variances have been replaced by the following three control ratios:

$$\text{production volume ratio} = \frac{\text{standard hours of actual output (27 000)}}{\text{budgeted hours of output (30 000)}} \times 100$$
$$= 90\%$$

$$\text{production efficiency ratio} = \frac{\text{standard hours of actual output (27 000)}}{\text{actual hours worked (28 500)}} \times 100$$
$$= 94.7\%$$

$$\text{capacity usage ratio} = \frac{\text{actual hours worked (28 500)}}{\text{budgeted hours of input (30 000)}} \times 100$$
$$= 95\%$$

You can interpret these ratios in the same way as was described for the equivalent monetary variances. The ratios merely represent the replacement of an *absolute* monetary measure with a *relative* performance measure.

A comparison of current variances with those of previous periods and/or with those of the year to date is presented in the summary of the performance report. This information is often useful in establishing a framework within which current variances can be evaluated. In addition to weekly or monthly performance reports, the manager of a responsibility centre should receive daily reports on those variances that are controllable on a daily basis.

This normally applies to material usage and labour efficiency. For these variances the weekly or monthly performance reports will provide a summary of the information that has previously been reported on a daily basis.

EXHIBIT 18.8
A typical departmental performance report

DEPARTMENTAL PERFORMANCE REPORT

Department.....
Period..... April 20XX.....

Actual production 27 000 standard hours
Actual working hours 28 500 hours
Budgeted hours 30 000 hours

Control ratios: Efficiency 94.7% Capacity 95% Volume 90%

DIRECT MATERIALS

Type	Standard quantity	Actual quantity	Difference	Standard price	Usage variance	Reason
A	18 000 kg	19 000	1000	£10.00	£10 000A	
B	9 000 kg	10 100	1100	£15.00	£16 500A	

DIRECT LABOUR

Grade	Standard hours	Actual hours	Difference	Standard cost	Actual cost	Total variance	Analysis: Efficiency	Analysis: Rate	Reason
	27 000	28 500	1500	£243 000	£273 600	£30 600	£13 500A	£17 100A	

OVERHEADS

	Allowed cost	Actual cost	Expenditure variance	Reason	Variable overhead efficiency variance (hours)	Variable overhead efficiency variance (£)
Controllable costs (variable):						
Indirect labour Power Maintenance Indirect materials				Difference between standard hours and actual hours at £2 per hour	1500	3000A
Total	£57 000	£52 000	£5000F		1500	3000A
Uncontrollable costs (fixed):						
Lighting and heating Depreciation Supervision						
	£120 000	116 000	4000F			

SUMMARY

	Variances (£)		Variances as a % of a standard cost	
	This month (£)	Cumulative (£)	This month (%)	Cumulative (%)
Direct materials usage	26 500A			
Direct labour:				
Efficiency	13 500A			
Wage rate	17 100A			
Controllable overheads:				
Expenditure	5 000F			
Variable overhead	3 000A			
Total	55 100A			
Comments:				

Recording standard costs in the accounts

If you are not studying for a specialist accounting qualification it is possible that your curriculum may not include the recording of standard costs. You should therefore check whether or not this topic is included in your curriculum to ascertain if you need to read this section. Standard costs can be used for planning, control, motivation and decision-making purposes without being entered into the books. However, the incorporation of standard costs into the cost accounting system greatly simplifies the task of tracing costs for inventory valuation and saves a considerable amount of data processing time. For example, if raw material stocks are valued at standard cost, the stock records may be maintained in terms of physical quantities only. The value of raw materials stock may be obtained simply by multiplying the physical quantity of raw materials in stock by the standard cost per unit. This avoids the need to record stocks on a first in, first out or average cost basis. The financial accounting regulations in most countries specify that inventory valuations based on standard costs may be included in externally published financial statements, provided the standard costs used are current and attainable. Most companies that have established standard costs therefore incorporate them into their cost accounting recording system.

Variations exist in the data accumulation methods adopted for recording standard costs, but these variations are merely procedural and the actual inventory valuations and profit calculations will be the same whichever method is adopted. In this chapter we shall illustrate a standard absorption costing system that values all inventories at standard cost, and all entries that are recorded in the inventory accounts will therefore be at *standard prices*. Any differences between standard costs and actual costs are debited or credited to variance accounts. Adverse variances will appear as debit balances, since they are additional costs in excess of standard. Conversely, favourable variances will appear as credit balances. Only production variances are recorded, and sales variances are not entered in the accounts.

Let us now consider the cost accounting records for Example 18.1, which was presented earlier in this chapter. We shall assume that the company operates an integrated cost

accounting system. The variances recorded in the accounts are those for an absorption costing system summarized in the reconciliation statement presented in Exhibit 18.7. The appropriate ledger entries are presented in Exhibit 18.9 (p. 524). Each ledger and journal entry has been labelled with numbers from 1 to 13 to try to give you a clear understanding of each accounting entry.

Purchase of materials

19 000 kg of raw material A at £11 per kg and 10 100 kg of raw material B at £14 per kg were purchased. This gives a total purchase cost of £209 000 for A and £141 400 for B. The standard prices were £10 per kg for A and £5 per kg for B. The accounting entries for material A are

1. Dr Stores ledger control account (AQ × SP)	190 000	
1. Dr Material price variance account	19 000	
1. Cr Creditors control account (AQ × AP)		209 000

You will see that the stores ledger control account is debited with the standard price (SP) for the actual quantity purchased (AQ), and the actual price (AP) to be paid is credited to the creditors control account. The difference is the material price variance. The accounting entries for material B are

2. Dr Stores ledger control account (AQ × SP)	151 500	
2. Cr Material price variance account		10 100
2. Cr Creditors (AQ × AP)		141 400

Usage of materials

19 000 kg of A and 10 100 kg of B were actually issued, and the standard usage (SQ) was 18 000 and 9000 kg at standard prices of £10 and £15. The accounting entries for material A are

3. Dr Work in progress (SQ × SP)	180 000	
3. Dr Material usage variance	10 000	
3. Cr Stores ledger control account (AQ × SP)		190 000

Work in progress is debited with the standard quantity of materials at the standard price and the stores ledger account is credited with the actual quantity issued at the standard price. The difference is the material usage variance. The accounting entries for material B are

4. Dr Work in progress (SQ × SP)	135 000	
4. Dr Material usage variance	16 500	
4. Cr Stores ledger control account (AQ × SP)		151 500

Direct wages

The actual hours worked were 28 500 hours for the month. The standard hours produced were 27 000. The actual wage rate paid was £9.60 per hour, compared with a

standard rate of £9 per hour. The actual wages cost is recorded in the same way in a standard costing system as an actual costing system. The accounting entry for the actual wages paid is

5. Dr Wages control account	273 600	
5. Cr Wages accrued account		273 600

The wages control account is then cleared as follows:

6. Dr Work in progress (SQ × SP)	243 000	
6. Cr Wages control account		243 000
6. Dr Wage rate variance	17 100	
6. Dr Labour efficiency variance	13 500	
6. Cr Wages control account		30 600

The wages control account is credited and the work in progress account is debited with the standard cost (i.e. standard hours produced times the standard wage rate). The wage rate and labour efficiency variance accounts are debited, since they are both adverse variances and account for the difference between the actual wages cost (recorded as a debit in the wages control account) and the standard wages cost (recorded as a credit in the wages control account).

Manufacturing overhead costs incurred

The actual manufacturing overhead incurred is £52 000 for variable overheads and £116 000 for fixed overheads. The accounting entries for actual overhead *incurred* are recorded in the same way in a standard costing system as in an actual costing system. That is,

7. Dr Factory variable overhead control account	52 000	
7. Dr Factory fixed overhead control account	116 000	
7. Cr Expense creditors		168 000

Absorption of manufacturing overheads and recording the variances

Work in progress is debited with the standard manufacturing overhead cost for the output produced. The standard overhead rates were £4 per standard hour for fixed overhead and £2 per standard hour for variable overheads. The actual output was 27 000 standard hours. The standard fixed overhead cost is therefore £108 000 (27 000 standard hours at £4 per hour) and the variable overhead cost is £54 000. The accounting entries for fixed overheads are

8. Dr Work in progress (SQ × SP)	108 000	
8. Dr Volume variance	12 000	
8. Cr Factory fixed overhead control account		120 000
8. Dr Factory fixed overhead control account	4 000	
8. Cr Fixed overhead expenditure variance		4 000

You will see that the debit of £108 000 to the work in progress account and the corresponding credit to the factory fixed overhead control account represents the standard fixed overhead cost of production. The difference between the debit entry of £116 000 in the factory fixed overhead control account in Exhibit 18.9 for the *actual* fixed overheads incurred, and the credit entry of £108 000 for the *standard* fixed overhead cost of production is the total fixed overhead variance, which consists of an adverse volume variance of £12 000 and a favourable expenditure variance of £4000. This is recorded as a debit to the volume variance account and a credit to the expenditure variance account. The accounting entries for variable overheads are

9. Dr Work in progress account (SQ × SP)	54 000	
9. Dr Variable overhead efficiency variance	3 000	
9. Cr Factory variable overhead control account		57 000
9. Dr Factory variable overhead control account	5 000	
9. Cr Variable overhead expenditure variance account		5 000

The same principles apply with variable overheads. The debit to work in progress account and the corresponding credit to the factory variable overhead control account of £54 000 is the standard variable overhead cost of production. The difference between the debit entry of £52 000 in the factory variable overhead account in Exhibit 18.9 for the *actual* variable overheads incurred and the credit entry of £54 000 for the *standard* variable overhead cost of production is the total variable overhead variance, which consists of an adverse efficiency variance of £3000 and a favourable expenditure variance of £5000.

Completion of production

In Exhibit 18.9 the total amount recorded on the debit side of the work in progress account is £720 000. As there are no opening or closing stocks, this represents the total standard cost of production for the period, which consists of 9000 units at £80 per unit. When the completed production is transferred from work in progress to finished goods stock, the accounting entries will be as follows:

10. Dr Finished stock account	720 000	
10. Cr Work in progress account		720 000

Because there are no opening or closing stocks, both the work in progress account and the stores ledger account will show a nil balance.

Sales

Sales variances are not recorded in the accounts, so actual sales of £810 000 for 9000 units will be recorded as

11. Dr Debtors	810 000	
11. Cr Sales		810 000

EXHIBIT 18.9

Accounting entries for a standard costing system

Stores ledger control account

1. Creditors (material A)	190 000	3. Work in progress (material A)	180 000
2. Creditors (material B)	151 500		
		3. Material usage variance (material A)	10 000
		4. Work in progress (material B)	135 000
		4. Material usage variance (material B)	16 500
	341 500		341 500

Creditors control account

2. Material price variance (material B)	10 100	1. Stores ledger control (material A)	190 000
		1. Material price variance (material A)	19 000
		2. Stores ledger control (material B)	151 500

Variance accounts

1. Creditors (material A)	19 000	2. Creditors (material price B)	10 100
3. Stores ledger control (material A usage)	10 000	8. Fixed factory overhead (expenditure)	4 000
4. Stores ledger control (material B usage)	16 500	9. Variable factory overhead (expenditure)	5 000
6. Wages control (wage rate)	17 100		19 100
6. Wages control (lab. effic'y)	13 500	13. Costing P + L a/c (balance)	72 000
8. Fixed factory overhead (volume)	12 000		
9. Variable factory overhead (effic'y)	3 000		
	91 100		91 100

Work in progress control account

3. Stores ledger (material A)	180 000	10. Finished goods stock account	720 000
4. Stores ledger (material B)	135 000		
6. Wages control	243 000		
8. Fixed factory overhead	108 000		
9. Variable factory overhead	54 000		
	720 000		720 000

Wages control account

5. Wages accrued account	273 600	6. WIP	243 000
		6. Wage rate variance	17 100
		6. Labour efficiency variance	13 500
	273 600		273 600

Fixed factory overhead control account

7. Expense creditors	116 000	8. WIP	108 000
8. Expenditure variance	4 000	8. Volume variance	12 000
	120 000		120 000

Variable factory overhead control account

7. Expense creditors	52 000	9. WIP	54 000
9. Expenditure	5 000	9. Efficiency variance	3 000
	57 000		57 000

Finished goods stock control account

10. WIP	720 000	12. Cost of sales	720 000

Cost of sales account

12. Finish goods stock	720 000	13. Costing P + L a/c	720 000

Costing P + L Account

12. Cost of sales at standard cost	720 000	11. Sales	810 000
13. Variance account (net variances)	72 000		
Profit for period	18 000		
	810 000		810 000

As all the production for the period has been sold, there will be no closing stock of finished goods, and the standard cost of production for the 9000 units will be transferred from the finished goods account to the cost of sales account:

12. Dr Cost of sales account	288 000	
12. Cr Finished goods account		288 000

Finally, the cost of sales account and the variance accounts will be closed by a transfer to the costing profit and loss account (the item labelled 13 in Exhibit 18.9). The balance of the costing profit and loss account will be the *actual* profit for the period.

Calculation of profit

To calculate the profit, we must add the adverse variances and deduct the favourable variances from the standard cost of sales, which is obtained from the cost of sales account. This calculation gives the actual cost of sales for the period, which is then deducted from the actual sales to produce the actual profit for the period. The calculations are as follows:

	(£)	(£)	(£)
Sales			810 000
Less standard cost of sales		720 000	
Plus adverse variances:			
Material A price variance	19 000		
Material usage variance	26 500		
Wage rate variance	17 100		
Labour efficiency variance	13 500		
Volume variance	12 000		
Variable overhead efficiency variance	3 000	91 100	
		811 100	
Less favourable variances:			
Material B price variance	10 100		
Fixed overhead expenditure variance	4 000		
Variable overhead expenditure variance	5 000	19 100	
Actual cost of sales			792 000
Actual profit			18 000



Summary

The following items relate to the learning objectives listed at the beginning of the chapter.

- **Explain how a standard costing system operates.**

  Standard costing is most suited to an organization whose activities consist of a series of repetitive operations and the input required to produce each unit of output can be specified. A standard costing system involves the following: (a) the standard costs for the actual output are recorded for each operation for each responsibility centre; (b) actual costs for each operation are traced to each responsibility centre; (c) the standard and actual costs are compared; (d) variances are investigated and corrective action is taken where appropriate; and (e) standards are monitored and adjusted to reflect changes in standard usage and/or prices.

- **Explain how standard costs are set.**

  Standards should be set for the quantities and prices of materials, labour and services to be consumed in performing each operation associated with a product. Product standard costs are derived by listing and adding the standard costs of operations required to produce a particular product. Two approaches are used for setting standard costs. First, past historical records can be used to estimate labour and material usage. Secondly, standards can be set based on engineering studies. With engineering studies a detailed study of each operation is undertaken under controlled conditions, based on high levels of efficiency, to ascertain the quantities of labour and materials required. Target prices are then applied based on efficient purchasing to ascertain the standard costs.

- **Explain the meaning of standard hours produced.**

  It is not possible to measure output in terms of units produced for a department making several different products or operations. This problem is overcome by ascertaining the amount of time, working under efficient operating conditions, it should take to make each product. This time calculation is called standard hours

produced. Standard hours thus represents an output measure that acts as a common denominator for adding together the production of unlike items.

- **Define basic, ideal and currently attainable standards.**

  Basic cost standards represent constant standards that are left unchanged over long periods. Ideal standards represent perfect performance. They represent the minimum costs that are possible under the most efficient operating conditions. Currently attainable standards represent those costs that should be incurred under efficient operating conditions. They are standards that are difficult, but not impossible, to achieve. Currently attainable standards are normally recommended for standard costing.

- **Identify and describe the purposes of a standard costing system.**

  Standard costing systems can be used for the following purposes: (a) providing a prediction of future costs that can be used for decision-making; (b) providing a challenging target which individuals are motivated to achieve; (c) providing a reliable and convenient source of data for budget preparation; (d) acting as a control device by highlighting those activities that do not conform to plan and thus alerting managers to those situations that may be 'out of control' and in need of corrective action; and (e) simplifying the task of tracing costs to products for profit measurement and inventory valuation purpose. Each purpose is described in more detail in Chapter 18.

- **Calculate labour, material, overhead and sales margin variances and reconcile actual profit with budgeted profit.**

  To reconcile actual profit with budget profit the favourable variances are added to the budgeted profit and adverse variances are deducted. The end result should be the actual profit. A summary of the formulae for the computation of the variances is presented in Exhibit 18.10. In each case the formula is presented so that a positive variance is favourable and a negative variance unfavourable.

- **Identify the causes of labour, material, overhead and sales margin variances.**

  Quantities cost variances arise because the actual quantity of resources consumed exceed actual usage. Examples include excess usage of materials and labour arising from the usage of inferior materials, careless handling of materials and failure to maintain machinery in proper condition. Price variances arise when the actual prices paid for resources exceed the standard prices. Examples include the failure of the purchasing function to seek the most efficient sources of supply or the use of a different grade of labour to that incorporated in the standard costs.

- **Construct a departmental performance report.**

  For an illustration of a departmental performance report you should refer to Exhibit 18.8.

- **Distinguish between standard variable costing and standard absorption costing.**

  With a standard variable costing system, fixed overheads are not allocated to products. Sales margin variances are therefore reported in terms of contribution margins and a single fixed overhead variance, that is, the fixed overhead expenditure variance is reported. With a standard absorption costing system, fixed overheads are allocated to products and this process leads to the creation of a fixed overhead volume variance and the reporting of sales margin variances measured in terms of profit margins. The fixed overhead volume variance is not particularly helpful for cost control purposes, but this variance is required for financial accounting purposes.

EXHIBIT 18.10

Summary of the formulae for the computation of the variances

The following variances are reported for both variable and absorption costing systems:

Materials and labour

1	Material price variance	= (standard price per unit of material – actual price) × quantity of materials purchased
2	Material usage variance	= (standard quantity of materials for actual production – actual quantity used) × standard price per unit
3	Total materials cost variance	= (actual production × standard material cost per unit of production) – actual materials cost
4	Wage rate variance	= (standard wage rate per hour – actual wage rate) × actual labour hours worked
5	Labour efficiency variance	= (standard quantity of labour hours for actual production – actual labour hours) × standard wage rate
6	Total labour cost variance	= (actual production × standard labour cost per unit of production) – actual labour cost

Fixed production overhead

7	Fixed overhead expenditure	= budgeted fixed overheads – actual fixed overheads

Variable production overhead

8	Variable overhead expenditure variance	= (budgeted variable overheads for actual input volume – actual variable overhead cost)
9	Variable overhead efficiency variance	= (standard quantity of input hours for actual production – actual input hours) × variable overhead rate
10	Total variable overhead variance	= (actual production × standard variable overhead rate per unit) – actual variable overhead cost

Sales margins

11	Sales margin price variance	= (actual unit contribution margin* – standard unit contribution margin) × actual sales volume

(*Contribution margins are used with a variable standard costing system whereas profit margins are used with an absorption costing system. With both systems, actual margins are calculated by deducting *standard* costs from actual selling price.)

12	Sales margin volume variance	= (actual sales volume – budgeted sales volume) × standard contribution margin

13	Total sales margin variance	= total actual contribution – total budgeted contribution

With a standard absorption costing system the following additional variances can be reported:

14	Fixed overhead volume variance	= (actual production – budgeted production) × standard fixed overhead rate
15	Volume efficiency variance	= (standard quantity of input hours for actual production – actual input hours) × standard fixed overhead rate
16	Volume capacity variance	= (actual hours of input – budgeted hours of input) × standard fixed overhead rate
17	Total fixed overhead variance	= (actual production × standard fixed overhead rate per unit) – actual fixed overhead cost

- **Prepare a set of accounts for a standard costing system.**

The method used in the chapter to illustrate the recording of standard costs valued all inventories at standard cost with all entries being recorded in the inventory accounts at standard prices. Any differences between standard costs and actual costs are debited or credited to variance accounts. Adverse variances appear as debit balances and favourable variances as credit balances. The preparation of a set of accounts for a standard costing system was illustrated in Exhibit 18.9.



Key terms and concepts

attainable standards (p. 497)
basic cost standards (p. 496)
bill of materials (p. 494)
budgeted costs (p. 490)
budgeted hours of input (p. 513)
budgeted hours of output (p. 513)
capacity usage ratio (p. 518)
engineering studies (p. 493)
fixed overhead expenditure variance (p. 509)
ideal standards (p. 497)
labour efficiency variance (p. 506)
material price variance (p. 502)
material usage variance (p. 503)
production efficiency ratio (p. 518)
production volume ratio (p. 518)
sales margin price variance (p. 511)
sales margin volume variance (p. 512)
standard costs (p. 490)
standard hours (p. 495)
standard hours produced (p. 495)
total fixed overhead variance (p. 514)
total labour variance (p. 507)
total material variance (p. 504)
total sales margin variance (p. 511)
total variable overhead variance (p. 507)
variable overhead efficiency variance (p. 508)
variable overhead expenditure variance (p. 508)
volume capacity variance (p. 516)
volume efficiency variance (p. 515)
volume variance (pp. 512, 514)
wage rate variance (p. 505)

Key examination points

A common error that students make is to calculate variances based on the original fixed budget. Remember to flex the budget. Therefore the starting point when answering a standard costing question should be to calculate actual production. If more than one product is produced, output should be expressed in standard hours. If standard overhead rates are not given, you can calculate the rates by dividing budgeted fixed and variable overheads by the budgeted output. Remember that output can be measured by units produced or standard hours produced. Make sure you are consistent and use overhead rates per standard hours if production is measured in standard hours, or overhead rates per unit produced if output is measured in terms of units produced. You should always express output in standard hours if the question requires the calculation of overhead efficiency variances. If the question does not specify whether you should calculate the variances on an absorption costing or variable costing basis, choose your preferred method and state the approach you have selected in your answer.

Frequently questions are set that give you the variances but require calculations of actual costs and inputs (see Review problems 18.29 and 18.30). Students who calculate variances simply by committing to memory a series of variance formulae experience difficulties in answering these questions. Make sure you understand how the variances are calculated, and check your answers with the solutions to the Review problems.



Assessment material

The review questions are short questions that enable you to assess your understanding of the main topics included in the chapter. The numbers in parentheses provide you with the page numbers to refer to if you cannot answer a specific question.

The review problems are more complex and require you to relate and apply the chapter content to various business problems. The problems are graded by their level of difficulty. The multiple-choice questions are the least demanding and normally take less than 10 minutes to complete. Fully worked solutions to the review problems are provided in a separate section at the end of the book. Further review problems with solutions for this chapter are available on the accompanying website www.drury-online.com. The website includes a *Student's Manual* and an *Instructor's Manual*. Students can access both questions and answers from the *Student's Manual* and the questions from the *Instructor's Manual*. The answers to problems in the *Instructor's Manual* are available only to lecturers on the lecturer's password-protected section of the website.

The website also includes over 20 case study problems. A list of these cases is provided on pages 586–7. Anjo Ltd and the Berkshire Toy Company are cases that are relevant to the content of this chapter.

Review questions

18.1 Describe the difference between budgeted and standard costs. (*p. 490*)

18.2 Explain how a standard costing system operates. (*pp. 490–3*)

18.3 Describe how standard costs are established using engineering studies. (*pp. 493–5*)

18.4 What are standard hours produced? What purpose do they serve? (*p. 495*)

18.5 What are basic, ideal and currently attainable standards? Which type of standards are usually adopted? Why? (*pp. 496–7*)

18.6 Describe the different purposes of a standard costing system. (*pp. 497–9*)

18.7 What are the possible causes of (a) material price and (b) material usage variances? (*pp. 502, 504*)

18.8 Explain why it is preferable for the material price variance to be computed at the point of purchase rather than the point of issue. (*pp. 503–4*)

18.9 What are the possible causes of (a) wage rate and (b) labour efficiency variances? (*p. 506*)

18.10 Explain how variable overhead efficiency and expenditure variances are computed. What are the possible causes of each of these variances? (*pp. 507–8*)

18.11 Why are sales variances based on contribution margins rather than sales revenues? (*p. 510*)

18.12 Distinguish between a standard absorption and a standard marginal costing system. (*pp. 512–3*)

18.13 What additional variance arises with a standard absorption costing system? Why? (*p. 514*)

18.14 How do sales variances differ between a standard absorption and marginal costing system? (*pp. 516–7*)

18.15 Explain what is meant by a volume variance. Does the volume variance provide any meaningful information for cost control? (*pp. 514–5*)

Review problems

18.16 During a period, 17 500 labour hours were worked at a standard cost of £6.50 per hour. The labour efficiency variance was £7800 favourable.

How many standard hours were produced?

A 1 200
B 16 300
C 17 500
D 18 700

18.17 A company has a budgeted material cost of £125 000 for the production of 25 000 units per month. Each unit is budgeted to use 2 kg of material. The standard cost of material is £2.50 per kg.

Actual materials in the month cost £136 000 for 27 000 units and 53 000 kg were purchased and used.

(a) What was the adverse material price variance?

(i) £1000
(ii) £3500
(iii) £7500
(iv) £11 000

(b) What was the favourable material usage variance?

(i) £2500
(ii) £4000
(iii) £7500
(iv) £10 000

ACCA Paper 1.2 – Financial Information for Management

18.18 The following information relates to labour costs for the past month:

Budget	Labour rate	£10 per hour
	Production time	15 000 hours
	Time per unit	3 hours
	Production units	5000 units
Actual	Wages paid	£176 000
	Production	5500 units
	Total hours worked	14 000 hours

There was no idle time.

What were the labour rate and efficiency variances?

	Rate variance	Efficiency variance
A	£26 000 adverse	£25 000 favourable
B	£26 000 adverse	£10 000 favourable
C	£36 000 adverse	£2500 favourable
D	£36 000 adverse	£25 000 favourable

ACCA Paper 1.2 – Financial Information for Management

18.19 Standard direct labour cost of one unit of product Q (0.25 hours × $12.00 per hour) is $3.00.

The eight employees who make product Q work a seven-hour day. In a recent three-day period, results were as follows:

Actual units produced	650 units
Actual wages cost	$2275

During this period, there was a power failure. This meant that all work had to stop for 2 hours.

(a) If the company reports idle time separately, the labour efficiency variance for the period is

(i) $258 (A)
(ii) $126 (A)
(iii) $42 (F)
(iv) $126 (F)

(b) The labour rate variance for the period is

(i) $451 (A)
(ii) $259 (A)
(iii) $266 (F)
(iv) $375 (F)

CIMA – Management Accounting Fundamentals

18.20 G Ltd repairs electronic calculators. The wages budget for the last period was based on a standard repair time of 24 minutes per calculator and a standard wage rate of $10.60 per hour.

Following the end of the budget period, it was reported that:

Number of repairs	31 000
Labour rate variance	$3100 (A)
Labour efficiency variance	Nil

Based on the above information, the actual wage rate during the period was

A $10.35 per hour
B $10.60 per hour
C $10.85 per hour
D $11.10 per hour

CIMA – Management Accounting Fundamentals

18.21 If fixed production overhead is over-absorbed in an accounting period, which ONE of the following combinations could have caused this result?

	Fixed overhead expenditure variance	and	Fixed overhead volume variance
A	$4200 (A)		$3750 (F)
B	$3250 (A)		$4170 (F)
C	$2240 (A)		$1870 (A)
D	$2980 (F)		$3690 (A)

CIMA – Management Accounting Fundamentals

18.22 QR Limited uses a standard absorption costing system. The following details have been extracted from its budget for April:

Fixed production overhead cost	£48 000
Production (units)	4 800

In April the fixed production overhead cost was under-absorbed by £8000 and the fixed production overhead expenditure variance was £2000 adverse.

The actual number of units produced was:

A 3800
B 4000
C 4200
D 5400
E 5800

CIMA Stage 2

18.23 Bowen has established the following with regard to fixed overheads for the past month:

Actual costs incurred	£132 400
Actual units produced	5000 units
Actual labour hours worked	9750 hours
Budgeted costs	£135 000
Budgeted units of production	4500 units
Budgeted labour hours	9000 hours

Overheads are absorbed on a labour hour basis.

What was the fixed overhead capacity variance?

A £750 favourable
B £11 250 favourable
C £22 500 favourable
D £11 250 adverse.

ACCA Paper 1.2 – Financial Information for Management

18.24 S Ltd makes a single product. The budget for October 2003 contained the following details:

Sales volume	12 000 units
Selling price per unit	$15.00
Cost per unit	$9.50

The actions of a competitor and an unexpected fall in material prices meant that actual results were:

Sales volume	10 800 units
Selling price per unit	$13.50
Cost per unit	$8.70

The total sales margin variance for October was

A $22 800 (A)
B $14 160 (A)
C $7560 (A)
D $9600 (A)

CIMA – Management Accounting Fundamentals

18.25 A company uses variance analysis to control costs and revenues.

Information concerning sales is as follows:

Budgeted selling price	£15 per unit
Budgeted sales units	10 000 units
Budgeted profit per unit	£5 per unit
Actual sales revenue	£151 500
Actual units sold	9800 units

What is the sales volume profit variance?

A £500 favourable
B £1000 favourable
C £1000 adverse
D £3000 adverse

ACCA Paper 1.2 – Financial Information for Management

18.26 A company is reviewing actual performance to budget to see where there are differences. The following standard information is relevant:

	£ per unit
Selling price	50
Direct materials	4
Direct labour	16
Fixed production overheads	5
Variable production overheads	10
Fixed selling costs	1
Variable selling cost	1
Total costs	37
Budgeted sales units	3000
Actual sales units	3500

What was the favourable sales volume variance using marginal costing?

A £9500
B £7500
C £7000
D £6500

ACCA Paper 1.2 – Financial Information for Management

18.27 **Calculation of absorption costing fixed overhead variances**

A company uses absorption costing for both internal and external reporting purposes as it has a considerable level of fixed production costs.

The following information has been recorded for the past year:

Budgeted fixed production overheads	£2 500 000
Budgeted (Normal) activity levels:	
Units	62 500 units
Labour hours	500 000 hours
Actual fixed production overheads	£2 890 350
Actual levels of activity:	
Units produced	70 000 units
Labour hours	525 000 hours

Required:

(a) Calculate the fixed production overhead expenditure and volume variances and briefly explain what each variance shows.

(5 marks)

(b) Calculate the fixed production overhead efficiency and capacity variances and briefly explain what each variance shows.

(5 marks)

ACCA Paper 1.2 – Financial Information for Management

18.28 Variance analysis and reconciliation of actual and budgeted profit

BS Limited manufactures one standard product and operates a system of variance accounting using a fixed budget. As assistant management accountant, you are responsible for preparing the monthly operating statements. Data from the budget, the standard product cost and actual data for the month ended 31 October are given below.

Using the data given, you are required to prepare the operating statement for the month ended 31 October to show the budgeted profit; the variances for direct materials, direct wages, overhead and sales, each analysed into causes; and actual profit.

Budgeted and standard cost data:

Budgeted sales and production for the month: 10 000 units
Standard cost for each unit of product:
Direct material: X: 10 kg at £1 per kg
Y: 5 kg at £5 per kg
Direct wages: 5 hours at £3 per hour
Fixed production overhead is absorbed at 200% of direct wages
Budgeted sales price has been calculated to give a profit of 20% of sales price

Actual data for month ended 31 October:

Production: 9500 units sold at a price of 10% higher than that budgeted
Direct materials consumed:
X: 96 000 kg at £1.20 per kg
Y: 48 000 kg at £4.70 per kg
Direct wages incurred 46 000 hours at £3.20 per hour
Fixed production overhead incurred £290 000

(30 marks)
CIMA Cost Accounting 2

18.29 Calculation of actual input data working back from variances

The following data relate to actual output, costs and variances for the four-weekly accounting period number 4 of a company that makes only one product. Opening and closing work in progress figures were the same.

	(£000)
Actual production of product XY	18 000 units
Actual costs incurred:	
Direct materials purchased and used (150 000 kg)	210
Direct wages for 32 000 hours	136
Variable production overhead	38

	(£000)
Variances:	
Direct materials price	15 F
Direct materials usage	9 A
Direct labour rate	8 A
Direct labour efficiency	16 F
Variable production overhead expenditure	6 A
Variable production overhead efficiency	4 F

Variable production overhead varies with labour hours worked.
A standard marginal costing system is operated.

You are required to:

(a) present a standard product cost sheet for one unit of product XY. *(16 marks)*

(b) describe briefly *three* types of standard that can be used for a standard costing system, stating which is usually preferred in practice and why. *(9 marks)*

(Total 25 marks)

CIMA Cost Accounting Stage 2

18.30 Calculation of actual quantities working backwards from variances

The following profit reconciliation statement summarizes the performance of one of SEWs products for March.

			(£)
Budgeted profit			4250
Sales volume variance			850A
Standard profit on actual sales			3400
Selling price variance			4000A
			(600)
Cost variances:	**Adverse (£)**	**Favourable (£)**	
Direct material price		1000	
Direct material usage	150		
Direct labour rate	200		
Direct labour efficiency	150		
Variable overhead expenditure	600		
Variable overhead efficiency	75		
Fixed overhead efficiency		2500	
Fixed overhead volume		150	
Actual profit	1175	3650	2475F
			1875

The budget for the same period contained the following data:

Sales volume		1500 units
Sales revenue	£20 000	
Production volume		1500 units
Direct materials purchased		750 kg
Direct materials used		750 kg
Direct material cost	£4 500	
Direct labour hours		1125
Direct labour cost	£4 500	
Variable overhead cost	£2 250	
Fixed overhead cost	£4 500	

Additional information:

- Stocks of raw materials and finished goods are valued at standard cost.
- During the month the actual number of units produced was 1550.
- The actual sales revenue was £12 000.
- The direct materials purchased were 1000 kg.

Required:

(a) Calculate

(i) the actual sales volume;

(ii) the actual quantity of materials used;

(iii) the actual direct material cost;

(iv) the actual direct labour hours;

(v) the actual direct labour cost;

(vi) the actual variable overhead cost;

(vii)the actual fixed overhead cost.

(19 marks)

(b) Explain the possible causes of the direct materials usage variance, direct labour rate variance and sales volume variance.

(6 marks)

(Total 25 marks)

CIMA Operational Cost Accounting Stage 2

18.31 Accounting entries for a standard costing system

Bronte Ltd manufactures a single product, a laminated kitchen unit with a standard cost of £80 made up as follows:

	(£)
Direct materials (15 sq. metres at £3 per sq. metre)	45
Direct labour (5 hours at £4 per hour)	20
Variable overheads (5 hours at £2 per hour)	10
Fixed overheads (5 hours at £1 per hour)	5
	80

The standard selling price of the kitchen unit is £100. The monthly budget projects production and sales of 1000 units. Actual figures for the month of April are as follows:

Sales 1200 units at £102
Production 1400 units
Direct materials 22 000 sq. metres at £4 per sq. metre
Direct wages 6800 hours at £5
Variable overheads £11 000
Fixed overheads £6000

You are required to prepare:

(a) a trading account reconciling actual and budgeted profit and showing all the appropriate variances

(13 marks)

(b) ledger accounts in respect of the above transactions.

*ICAEW Accounting Techniques**

(*The original examination question did not include part (b).)



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APPENDICES

Present value of £1 after n years = £1(1+k)^n

4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%	26%
0.962	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800	0.794
0.925	0.890	0.857	0.826	0.797	0.769	0.756	0.743	0.718	0.694	0.672	0.650	0.640	0.630
0.889	0.840	0.794	0.751	0.712	0.675	0.658	0.641	0.609	0.579	0.551	0.524	0.512	0.500
0.855	0.792	0.735	0.683	0.636	0.592	0.572	0.552	0.516	0.482	0.451	0.423	0.410	0.397
0.822	0.747	0.681	0.621	0.567	0.519	0.497	0.476	0.437	0.402	0.370	0.341	0.328	0.315
0.790	0.705	0.630	0.564	0.507	0.456	0.432	0.410	0.370	0.335	0.303	0.275	0.262	0.250
0.760	0.665	0.583	0.513	0.452	0.400	0.376	0.354	0.314	0.279	0.249	0.222	0.210	0.198
0.731	0.627	0.540	0.467	0.404	0.351	0.327	0.305	0.266	0.233	0.204	0.179	0.168	0.157
0.703	0.592	0.500	0.424	0.361	0.308	0.284	0.263	0.225	0.194	0.167	0.144	0.134	0.125
0.676	0.558	0.463	0.386	0.322	0.270	0.247	0.227	0.191	0.162	0.137	0.116	0.107	0.099
0.650	0.527	0.429	0.350	0.287	0.237	0.215	0.195	0.162	0.135	0.112	0.094	0.086	0.079
0.625	0.497	0.397	0.319	0.257	0.208	0.187	0.168	0.137	0.112	0.092	0.076	0.069	0.062
0.601	0.469	0.368	0.290	0.229	0.182	0.163	0.145	0.116	0.093	0.075	0.061	0.055	0.050
0.577	0.442	0.340	0.263	0.205	0.160	0.141	0.125	0.099	0.078	0.062	0.049	0.044	0.039
0.555	0.417	0.315	0.239	0.183	0.140	0.123	0.108	0.084	0.065	0.051	0.040	0.035	0.031
0.534	0.394	0.292	0.218	0.163	0.123	0.107	0.093	0.071	0.054	0.042	0.032	0.028	0.025
0.513	0.371	0.270	0.198	0.146	0.108	0.093	0.080	0.060	0.045	0.034	0.026	0.023	0.020
0.494	0.350	0.250	0.180	0.130	0.095	0.081	0.069	0.051	0.038	0.028	0.021	0.018	0.016
0.475	0.331	0.232	0.164	0.116	0.083	0.070	0.060	0.043	0.031	0.023	0.017	0.014	0.012
0.456	0.312	0.215	0.149	0.104	0.073	0.061	0.051	0.037	0.026	0.019	0.014	0.012	0.010

Present value of an annuity of £1 received anually

4%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%	26%	28%	30
0.962	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800	0.794	0.781	0.7
1.886	1.833	1.783	1.736	1.690	1.647	1.626	1.605	1.566	1.528	1.492	1.457	1.440	1.424	1.392	1.3
2.775	2.673	2.577	2.487	2.402	2.322	2.283	2.246	2.174	2.106	2.042	1.981	1.952	1.923	1.868	1.8
3.630	3.465	3.312	3.170	3.037	2.914	2.855	2.798	2.690	2.589	2.494	2.404	2.362	2.320	2.241	2.1
4.452	4.212	3.993	3.791	3.605	3.433	3.352	3.274	3.127	2.991	2.864	2.745	2.689	2.635	2.532	2.4
5.242	4.917	4.623	4.355	4.111	3.889	3.784	3.685	3.498	3.326	3.167	3.020	2.951	2.885	2.759	2.6
6.002	5.582	5.206	4.868	4.564	4.288	4.160	4.039	3.812	3.605	3.416	3.242	3.161	3.083	2.937	2.8
6.733	6.210	5.747	5.335	4.968	4.639	4.487	4.344	4.078	3.837	3.619	3.421	3.329	3.241	3.076	2.9
7.435	6.802	6.247	5.759	5.328	4.946	4.772	4.607	4.303	4.031	3.786	3.566	3.463	3.366	3.184	3.0
8.111	7.360	6.710	6.145	5.650	5.216	5.019	4.833	4.494	4.192	3.923	3.682	3.571	3.465	3.269	3.0
8.760	7.887	7.139	6.495	5.937	5.453	5.234	5.029	4.656	4.327	4.035	3.776	3.656	3.544	3.335	3.1
9.385	8.384	7.536	6.814	6.194	5.660	5.421	5.197	4.793	4.439	4.127	3.851	3.725	3.606	3.387	3.1
9.986	8.853	7.904	7.103	6.424	5.842	5.583	5.342	4.910	4.533	4.203	3.912	3.780	3.656	3.427	3.2
0.563	9.295	8.244	7.367	6.628	6.002	5.724	5.468	5.008	4.611	4.265	3.962	3.824	3.695	3.459	3.2
1.118	9.712	8.559	7.606	6.811	6.142	5.847	5.575	5.092	4.675	4.315	4.001	3.859	3.726	3.483	3.2
1.652	10.106	8.851	7.824	6.974	6.265	5.954	5.669	5.162	4.730	4.357	4.033	3.887	3.751	3.503	3.2
2.166	10.477	9.122	8.022	7.120	6.373	6.047	5.749	5.222	4.775	4.391	4.059	3.910	3.771	3.518	3.2
2.659	10.828	9.372	8.201	7.250	6.467	6.128	5.818	5.273	4.812	4.419	4.080	3.928	3.786	3.529	3.3
3.134	11.815	9.604	8.365	7.366	6.550	6.198	5.877	5.316	4.844	4.442	4.097	3.942	3.799	3.539	3.3
3.590	11.470	9.818	8.514	7.469	6.623	6.259	5.929	5.353	4.870	4.460	4.110	3.954	3.808	3.546	3.3



ANSWERS TO REVIEW PROBLEMS

Chapter 2

2.15 (a) SV (or variable if direct labour can be matched exactly to output)
(b) F
(c) F
(d) V
(e) F (Advertising is a discretionary cost. See Chapter 17 for an explanation of this cost.)
(f) SV
(g) F
(h) SF
(i) V

2.16 Controllable c, d, f
Non-controllable a, b, e, g, h

2.17 Item (B) will be constant within the relevant range of output.
Item (C) will be constant per unit.
If output declines fixed cost per unit will decrease.
Total variable cost will fall in line with a decline in output and therefore item A is the correct answer.

2.18 Answer = D

2.19 Total variable overheads = 17 000 × £3.50 = £59 500
Total variable overhead (£59 500) + Total fixed overhead = Total overhead (£246 500)
Total fixed overhead = £246 500 – £59 500 = £187 000
Answer = C

2.20 Answer = B

2.21 Answer = B

2.22 Answer = B

2.23 Answer = B

2.24 See the description of cost behaviour in Chapter 2 for the answer to these questions. In particular the answer should provide graphs for fixed costs, variable costs, semi-fixed costs and semi-variable costs.

2.25 You will find the answer to this question in Chapter 2. In particular the answer should describe the classification of costs for stock valuation and profit measurement; classification for decision-making and planning; classification for control. In addition the answer should illustrate methods of classification (see Chapter 2 for examples) within the above categories and describe the benefits arising from classifying costs in the manner illustrated.

2.26 See Chapter 2 for the answer to this question.

2.27 (a) See 'Functions of management accounting' in Chapter 1 for the answer to this question. In particular your answer should stress that the cost accountant provides financial information for stock valuation purposes and also presents relevant information to management for decision-making and planning and cost control purposes. For example, the cost accountant provides information on the costs and revenues of alternative courses of action to assist management in selecting the course of action which will maximize future cash flows. By coordinating plans together in the form of budgets and comparing actual performance with plans the accountant can pinpoint those activities which are not proceeding according to plan.
(b) (i) Direct costs are those costs which can be traced to a cost objective. If the cost objective is a sales territory then *fixed* salaries of salesmen will be a direct cost. Therefore the statement is incorrect.
(ii) Whether a cost is controllable depends on the level of authority and time span being considered. For example, a departmental foreman may have no control over the number of supervisors employed in his department but this decision may be made by his superior. In the long term such costs are controllable.
(iii) This statement is correct. See 'Sunk costs' in Chapter 2 for an explanation of why this statement is correct.

2.28 See Chapter 2 for the answer to this question.

2.29 Cost information is required for the following purposes:
(a) costs for stock valuation and profit measurement;
(b) costs for decision-making;
(c) costs for planning and control.
For the alternative measures of cost that might be appropriate for each of the above purposes see Chapter 2.

2.30 (i) See Chapter 2 for a definition of opportunity cost and sunk cost.
(ii) *Opportunity cost:* If scarce resources such as machine hours are required for a special contract then the cost of the contract should include the lost profit that

would have been earned on the next best alternative. This should be recovered in the contract price.

Sunk cost: The original cost of equipment used for a contract is a sunk cost and should be ignored. The change in the resale value resulting from the use of the equipment represents the relevant cost of using the equipment.

(iii) The significance of opportunity cost is that relevant costs do not consist only of future cash outflows associated directly with a particular course of action. Imputed costs must also be included.

The significance of sunk costs is that past costs are not relevant for decision-making.

2.31 See Chapter 2 for an explanation of the terms avoidable costs and unavoidable costs and Chapter 4 for an explanation of cost centres. A cost unit is a unit of product or service for which costs are ascertained. In a manufacturing organization a cost unit will be a unit of output produced within a cost centre. In a service organization, such as an educational establishment, a cost unit might be the cost per student.

2.32 (a) (i) Schedule of annual mileage costs

	5000 miles (£)	10 000 miles (£)	15 000 miles (£)	30 000 miles (£)
Variable costs:				
Spares	100	200	300	600
Petrol	380	760	1140	2280
Total variable cost	480	960	1440	2880
Variable cost per mile	0.096	0.096	0.096	0.096
Fixed costs:				
Depreciation[a]	2000	2000	2000	2000
Maintenance	120	120	120	120
Vehicle licence	80	80	80	80
Insurance	150	150	150	150
Tyres[b]	—	—	75	150
	2350	2350	2425	2500
Fixed cost per mile	0.47	0.235	0.162	0.083
Total cost	2830	3310	3865	5380
Total cost per mile	0.566	0.331	0.258	0.179

Notes

[a]Annual depreciation

$$= \frac{\text{£5500 (cost)} - \text{£1500 (trade-in price)}}{2 \text{ years}} = \text{£2000}$$

[b]At 15 000 miles per annum tyres will be replaced once during the two-year period at a cost of £150. The average cost per year is £75. At 30 000 miles per annum tyres will be replaced once each year.

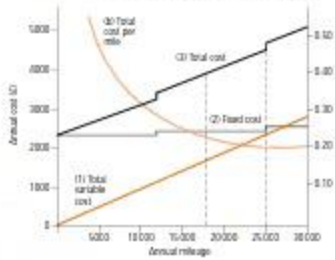
Comments

Tyres are a semi-fixed cost. In the above calculations they have been regarded as a step fixed cost. An alternative approach would be to regard the semi-fixed cost as a variable cost by dividing £150 tyre replacement by 25 000 miles. This results in a variable cost per mile of £0.006.

Depreciation and maintenance cost have been classified as fixed costs. They are likely to be semi-variable costs, but in the absence of any additional information they have been classified as fixed costs.

(ii) See Figure 2.32.

FIGURE 2.32 *The step increase in fixed cost is assumed to occur at an annual mileage of 12 500 and 25 000 miles, because tyres are assumed to be replaced at this mileage*



(iii) The respective costs can be obtained from the vertical dashed lines in the graph (Figure 2.32).

(b) The *cost per mile* declines as activity increases. This is because the majority of costs are fixed and do not increase when mileage increases. However, *total cost* will increase with increases in mileage.

2.33 (a) (i) For an explanation of sunk and opportunity costs see Chapter 2. The down payment of £5000 represents a sunk cost. The lost profit from subletting the shop of £1600 p.a. ((£550 × £12) – £5000) is an example of an opportunity cost. Note that only the £5000 additional rental is included in the opportunity cost calculation. (The £5000 sunk cost is excluded from the calculation.)

(ii) The relevant information for running the shop is:

	(£)
Net sales	100 000
Costs (£87 000 – £5000 sunk cost)	82 000
	18 000
Less opportunity cost from subletting	1 600
Profit	16 400

The above indicates that £16 400 additional profits will be obtained from using the shop for the sale of clothing. It is assumed that Mrs Johnson will not suffer any other loss of income if she devotes half her time to running the shop.

(b) The CIMA terminology defines a notional cost as 'A hypothetical cost taken into account in a particular situation to represent a benefit enjoyed by an entity in respect of which no actual expense is incurred.'

Examples of notional cost include:

(i) Interest on capital to represent the notional cost of using an asset rather than investing the capital elsewhere.

(ii) Including rent as a cost for premises owned by the company so as to represent the lost rent income resulting from using the premises for business purposes.

Chapter 3

3.16 Overtime premium = hours overtime at $5.10 = $35.70
Answer = B

3.17

	$	$
Direct materials		5 500
Direct expenses		14 500
Staff salaries:		
1 020 hours × $24.00	24 480	
Overtime hours 40 hours × $6.00	240	24 720
		44 720

Answer = C

3.18 Answer = D (Note that is updated from other documents besides a goods received note)

3.19 Answer = C

3.20 Production will be charged at the most recent (higher prices) resulting in lower profits and stocks will consist of the earlier (lower prices). Therefore answer = A.

3.21 Answer = D

3.22 (a) Purchases are 460 units and issues are 420 units resulting in a closing stock of 40 units. Therefore closing stock valuation = 40 units at the latest purchase price ($1.90) = $76. Therefore answer = D
(b) Answer = C (see outcomes for Example 3.2 in the text)

3.23

	Receipts and issues	
Units	Price per unit	Cost
100	5 00	500
150	5 50	825
250	5 30	1,325
(100)	5 30	(530)
100	6 00	600
250	5 58	1,395
(75)	5 58	(418 5)
175	5 58	976 50

Answer = B

3.24 Answer = C

3.25
$$EOQ = \sqrt{(2DO)/H} = \sqrt{\frac{[2\times(50+5)\times4000}{(15\times0.1)+0.2]}}$$
$$= 509 \text{ units}$$
Answer = D

3.26 (i) Re-order level = Maximum usage × Maximum lead time
= 95 × 18 = 1710
Answer = C

(ii) Maximum stock = Re-order level + Re-Order quantity − Minimum usage during minimum lead time
= 1710 + 1750 − (50 × 12)
= 2860
Answer = B

3.27 Answer = D

3.28 Annual holding cost = EOQ/2 × £4 per unit = 250 units × £4 = £1000
Annual ordering costs = Annual demand of 20 000 units/EOQ (500 units) × ordering cost (£25) = £1000
Annual purchase cost = 20 000 units × £40 = £800 000
Total annual cost = £1000 + £1000 + £800 000 = £802 000
Answer = C

3.29 (a) *Advantages:*
(i) Both the firm and the employee should benefit from the introduction of an incentive scheme. Employees should receive an increase in wages arising from the increased production. The firm should benefit from a reduction in the fixed overhead per unit and an increase in sales volume.
(ii) The opportunity to earn higher wages may encourage efficient workers to join the company.
(iii) Morale may be improved if extra effort is rewarded.
Disadvantages:
(i) Incentive schemes can be complex and difficult to administer.
(ii) Establishing performance levels leads to frequent and continuing disputes.
(iii) The quality of the output may decline.

(b)
(i) Hourly rate
Employee A 38 × £3.00 = £114.00
B 36 × £2.00 = £72.00
C 40 × £2.50 = £100.00
D 34 × £3.60 = £122.40

(ii) Piecework
Employee A (42 × £0.30) + (72 × £0.45) + (92 × £0.75) = £114
B (120 × £0.30) + (76 × £0.45) = £70.20
C (50 × £0.75) = £37.50
D (120 × £0.30) + (270 × £0.45) = £157.50

Note that with the piecework system the employees are paid an agreed rate per unit produced. The piece rates are £0.30 per unit for X (6 minutes × £0.05), £0.45 for Y (9 × £0.05) and £0.75 for Z (15 × £0.05). Only employee C earns less than 75% of basic pay. Therefore C will receive a gross wage of £75. The piecerate wages should be charged directly to the products and the difference between the guaranteed minimum wage of £75 and the piecework wage of £37.50 for employee C should be charged to an appropriate overhead account.

With a bonus scheme a set time is allowed for each job and a bonus is paid based on the proportion of time saved. The calculations for each employee are:

	Time allowed (hours)	Time saved (hours)	Bonus (£)	Total wages (£)
A	$\frac{42\times6}{60}+\frac{72\times9}{60}+\frac{92\times15}{60}=38$	0	0	114
B	$\frac{120\times6}{60}+\frac{76\times9}{60}=23.4$	0	0	72
C	$\frac{50\times15}{60}=12.5$	0	0	100
D	$\frac{120\times6}{60}+\frac{270\times9}{60}=52.5$	18.5	$\frac{3}{4}\times18.5\times£3.60=£44.40$	£122.40 + £44.40

Employees A, B and C do not earn a bonus because the time taken is in excess of time allowed.

3.30 (i) Current average maximum production = 30 × 55 hrs × 6 units = 9900 units. Proposed maximum production = 30 × 55 hrs × 8 units = 13 200 units

Existing payment system:

Output level (units)	7 000	9 600	9 900	
	£	£	£	
Sales value (£11 per unit)	77 000	105 600	108 900	
Pre-finishing VC	56 000	76 800	79 200	
Direct labour:				
Guaranteed	9 600	9 600	9 600	
Overtime (*W*1)	—	4 800	5 400	
Variable overhead (*W*2)	560	768	792	
Fixed overhead	9 000	9 000	9 000	
Total cost	75 160	100 968	103 992	
Profit	1 840	4 632	4 908	

Proposed scheme:

Output level (units)	7 000	9 600	9 900	12 000
	£	£	£	£
Sales value	77 000	105 600	108 900	132 000
Pre-finishing VC	56 000	76 800	79 200	96 000
Direct labour at £1.40 per unit	9 800	13 440	13 860	16 800
Variable overhead (*W*3)	420	576	594	720
Fixed overhead	9 000	9 000	9 000	9 000
Total cost	75 220	99 816	102 654	122 520
Profit	1 780	5 784	6 246	9 480

Working:

(*W*1) 9600 units requires 1600 hrs (9600/6)
∴ (Overtime = 400 hrs × £12
9900 units requires 1650 hrs (9900/6)
∴ (Overtime = 450 hrs × £12
Basic hours = 1200 hrs

(*W*2) 7000 units = 7000/6 × £0.48
9600 units = 9600/6 × £0.48
9900 units = 9900/6 × £0.48

(*W*3) 7000 units = 7000/8 × £0.48
9600 units = 9600/8 × £0.48
9900 units = 9900/8 × £0.48
12 000 units = 12 000/8 × £0.48

(ii) At low output levels the average wage rate per unit is £1.33 (£8/6 units), compared with £1.40 with the incentive scheme. However, once overtime is worked, the wage rate per unit of output exceeds £1.40 per unit under the incentive scheme. For example, at an output level of 9600 units the wage rate per unit of output is £1.50 (£14 400/9600).

Variable overheads vary with productive hours. Therefore variable overhead per unit will be £0.08 (£0.48/6) under the old scheme and £0.06 per unit under the new scheme (£0.48/8).

The proposed incentive scheme will also enable the maximum output level to be achieved, thus enabling maximum sales to be achieved.

3.31 Re-order level = Maximum usage (750) × Maximum lead time (15 days) = 11 250 units
Minimum stock reduction before an order is received = 11 250 – (450 × 8days) = 7 650 units
Maximum order size = 15 000 – 7 650 = 7 350 units
Answer = 7 350 units

3.32 (a) EOQ = $\sqrt{(2 \times 15\,000 \times 80)/(0.1333 \times 200)}$ = 300 units
Number of orders per year = 15 000/300 = 50 orders
(b) EOQ = $\sqrt{(2 \times 2\,800 \times 28)/(25 \times .08)}$ = 280 units
Holding cost = 280/2 × £2 = $280

3.33 (a) EOQ = $\sqrt{(2 \times 12\,000 \times 200)/(£15 \times 0.08)}$ = 2 000 units
(b) Revised stock costs

	£
Purchase costs (12 000 × £15)	180 000
Order costs $\frac{12000}{2000}\times200$	1 200
Holding costs $\frac{2000}{2}\times15\times0.08$	1 200
	182 400
Original stock costs	183 000
Saving	600

Chapter 4

4.12 Overhead absorbed (£714 000) = Actual hours (119 000) × Predetermined overhead rate.
Predetermined overhead rate = £714 000/119 000 = £6.
Budgeted overheads (£720 000) = Budgeted machine hours × Budgeted overhead rate (£6).
Budgeted machine hours = £720 000/£6 = 120 000 hours.
Answer = C

4.13 Budgeted overhead rate = £258 750/11 250 hours = £23 per machine hour
Overheads absorbed = £23 × 10 980 Actual hours = £252 540
Overheads incurred = £254 692
Overheads absorbed = £252 540
Under-absorbed overheads = £2152
Answer = A

4.14 (i) Budgeted overhead rates and not actual overhead rates should be used as indicated in Chapter 3.
Overhead rate = £148 750/8500 hours = £17.50 per hour.
Answer = A

(ii)

	(£)
Actual overheads incurred	146 200
Overheads absorbed (7928 × £17.50)	138 740
Under-absorbed overheads	7 460

Answer = D

4.15 Budgeted machine hour rate = $3.60 ($180 000/50 000 hours)
Standard machine hours per unit = 1.25 (50 000 hours/40 000 units)

	$
Overheads incurred	178 080
Overheads absorbed (38 760 units × 1.25 hours × $3.60) =	174 420
Under absorbed overheads	3 660

Answer = B

4.16

	£
Absorbed overheads (4 500 units × £8)	36 000
Over absorbed overheads	(6 000)
Actual overheads incurred	30 000

Answer = A

4.17 Answer = D

4.18 Because production is highly automated it is assumed that overheads will be most closely associated with machine hours. The pre-determined overhead rate will therefore be £18 derived from dividing budgeted overheads (£180 000) by the budgeted machine hours (10 000). Therefore the answer is B.

4.19 Items that contribute to the over-absorption of overheads are if actual production exceeds budgeted production or actual overhead expenditure is less than budgeted expenditure. When both of these items occur overheads will be over-absorbed. Therefore the answer is D.

4.20

Direct materials	10 650
Direct labour	3 260
Prime cost	13 910
Production overhead (140 × $8.50)	1 190
Non-manufacturing overheads and profit (60% × $13 910)	8 346
Estimated price	23 446

Answer = C

4.21 Answer = D

4.22 Stores (S) = 6300 + 0.05 Maintenance (M)
M = 8450 + 0.1S
Rearranging the equations:
S = 6300 + 0.05M (1)
–0.1S = 8450 – M (2)
Multiply equation (1) by 20 and (2) by 1
20S = 126 000 + M
–0.1S = 8450 – M
19.9S = 134 450
S = £6756
Substituting for S in equation (1)
6756 = 6300 + 0.05M
0.05M = 456
M = £9126
For production department 1, the total overheads are
= 17 500 + (£6756 × 60%) + (9126 × 75%)
= £28 398
Answer = C

4.23 (a)

	Total (£)	A (£)	Departments B (£)	C (£)	X (£)	Y (£)
Rent and rates[a]	12 800	6 000	5 600	1 200	1200	800
Machine insurance[b]	6 800	3 000	1 250	1 800	500	250
Telephone charges[c]	3 200	1 500	900	300	300	200
Depreciation[b]	18 800	9 000	3 750	5 800	1500	750
Supervisors' salaries[d]	24 800	12 800	7 200	4 800		
Heat and light[a]	6 400	3 000	1 800	600	600	400
	70 400					
Allocated		35 300	20 500	14 700	4100	2600
Reapportionment of X		2 460 (50%)	1 230 (25%)	1 230 (25%)	(4100)	
Reapportionment of Y		663 (26%)	950 (36%)	1 300 (50%)		(2600)
		£41 153	£22 325	£16 825		
Budgeted D.L. hours[e]		3 200	1 600	1 800		
Absorption rates		£12.86	£13.40	£14.02		

Notes
[a]Apportioned on the basis of floor area.
[b]Apportioned on the basis of machine value.
[c]Should be apportioned on the basis of the number of telephone points or estimated usage. This information is not given and an alternative arbitrary method of apportionment should be chosen. In the above analysis telephone charges have been apportioned on the basis of floor area.
[d]Apportioned on the basis of direct labour hours.
[e]Machine hours are not given but direct labour hours are. It is assumed that the examiner requires absorption to be on the basis of direct labour hours.

(b)

	Job 123 (£)	Job 124 (£)
Direct material	154.00	108.00
Direct labour:		
Department A	76.00	60.80
Department B	42.00	35.00
Department C	34.00	47.60
Total direct cost	306.00	251.40
Overhead:		
Department A	257.20	205.76
Department B	148.80	124.00
Department C	140.20	196.28
Total cost	852.20	777.44
Profit	284.07	259.15

4.14 (i) Budgeted overhead rates and not actual overhead rates should be used as indicated in Chapter 3.
Overhead rate = £148 750/8500 hours = £17.50 per hour.
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(ii)

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Actual overheads incurred	146 200
Overheads absorbed (7928 × £17.50)	138 740
Under-absorbed overheads	7 460

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Standard machine hours per unit = 1.25 (50 000 hours/40 000 units)

	$
Overheads incurred	178 080
Overheads absorbed (38 760 units × 1.25 hours × $3.60) =	174 420
Under absorbed overheads	3 660

Answer = B

4.16

	£
Absorbed overheads (4 500 units × £8)	36 000
Over absorbed overheads	(6 000)
Actual overheads incurred	30 000

Answer = A

4.17 Answer = D

4.18 Because production is highly automated it is assumed that overheads will be most closely associated with machine hours. The pre-determined overhead rate will therefore be £18 derived from dividing budgeted overheads (£180 000) by the budgeted machine hours (10 000). Therefore the answer is B.

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For production department 1, the total overheads are
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4.23 (a)

	Total (£)	A (£)	Departments B (£)	C (£)	X (£)	Y (£)
Rent and rates[a]	12 800	6 000	5 600	1 200	1200	800
Machine insurance[b]	6 800	3 000	1 250	1 800	500	250
Telephone charges[c]	3 200	1 500	900	300	300	200
Depreciation[b]	18 800	9 000	3 750	5 800	1500	750
Supervisors' salaries[d]	24 800	12 800	7 200	4 800		
Heat and light[a]	6 400	3 000	1 800	600	600	400
	70 400					
Allocated		35 300	20 500	14 700	4100	2600
Reapportionment of X		2 460 (50%)	1 230 (25%)	1 230 (25%)	(4100)	
Reapportionment of Y		663 (26%)	950 (36%)	1 300 (50%)		(2600)
		£41 153	£22 325	£16 825		
Budgeted D.L. hours[e]		3 200	1 600	1 800		
Absorption rates		£12.86	£13.40	£14.02		

Notes
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[d]Apportioned on the basis of direct labour hours.
[e]Machine hours are not given but direct labour hours are. It is assumed that the examiner requires absorption to be on the basis of direct labour hours.

(b)

	Job 123 (£)	Job 124 (£)
Direct material	154.00	108.00
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Department C	140.20	196.28
Total cost	852.20	777.44
Profit	284.07	259.15

(d) Department A (40 machine hours × £3) 120
B (40 labour hours × £0.60) 24
C (10 labour hours × £3) 30
174

(e) (i) *Current rate (actual wages × 150%):*

	Absorbed (£000s)	Actual (£000s)	Over/(under)-absorbed (£000s)
Department A	45	130	(85)
B	120	28	92
C	45	80	(35)
	210	238	(28)

(ii) *Proposed rates:*

	Absorbed (£000s)	Actual (£000s)	Over/(under)-absorbed (£000s)
Department A	135	130	5
B	27	28	(1)
C	90	80	10
	252	238	14

4.26 (a) The calculation of the overhead absorption rates are as follows:
Forming department machine hour rate = £6.15 per machine hour (£602 700/98 000 hours)
Finishing department labour hour rate = £2.25 per labour hour (£346 500/154 000 hours)
The forming department is mechanized, and it is likely that a significant proportion of overheads will be incurred as a consequence of employing and running the machines. Therefore a machine hour rate has been used. In the finishing department several grades of labour are used. Consequently the direct wages percentage method is inappropriate, and the direct labour hour method should be used.

(b) The decision should be based on a comparison of the incremental costs with the purchase price of an outside supplier if spare capacity exists. If no spare capacity exists then the lost contribution on displaced work must be considered. The calculation of incremental costs requires that the variable element of the total overhead absorption rate must be calculated. The calculation is:
Forming department variable machine hour rate = £2.05 (£200 900/98 000 hours)
Finishing department variable direct labour hour rate = £0.75 (£115 500/154 000 hours)
The calculation of the variable costs per unit of each component is:

	A (£)	B (£)	C (£)
Prime cost	24.00	31.00	29.00
Variable overheads: Forming	8.20	6.15	4.10
Finishing	2.25	7.50	1.50
Variable unit manufacturing cost	34.45	44.65	34.60
Purchase price	£30	£65	£60

On the basis of the above information, component A should be purchased and components B and C manufactured. This decision is based on the following assumptions:

(i) Variable overheads vary in proportion to machine hours (forming department) and direct labour hours (finishing department).
(ii) Fixed overheads remain unaffected by any changes in activity.
(iii) Spare capacity exists.
For a discussion of make-or-buy decisions see Chapter 10.

(c) Production overhead absorption rates are calculated in order to ascertain costs per unit of output for stock valuation and profit measurement purposes. Such costs are inappropriate for decision-making and cost control. For an explanation of this see the section in Chapter 4 titled 'Different costs for different purposes'.

4.27 (i) Percentage of direct material cost = $\frac{£250\,000}{£100\,000} \times 100 = 250\%$
Direct labour hour rate = £250 000/50 000 hours = £5 per hour

(ii) Percentage material cost = 250% × £7000 = £17 500
Direct labour cost = 800 × £5 = £4000

(iii) Overhead incurred £350 000
Overhead absorbed £275 000 (55 000 × £5)
Under absorption of overhead £75 000
The under absorption of overhead should be regarded as a period cost and charged to the profit and loss account.

(iv) The answer should stress the limitations of the percentage of direct material cost method and justify why the direct labour hour method is the most frequently used method in non-machine paced environments. See Appendix 4.2 for a more detailed answer to this question.

4.28 (a) It is easier to allocate service department B first because it provides services to both of the other service departments.

	Centre 1 (£)	Centre 2 (£)	Service A (£)	Service B (£)	Service C (£)
	2000	3000	300	500	700
Service B	250 (50%)	300 (20%)	100 (20%)	(500)	50 (10%)
	2250	3300	400		750
Service A	180 (45%)	180 (45%)	(400)	40 (10%)	
	2430	3480		40	750
Service C	450 (60%)	300 (40%)			(750)
	2880	3780		40	
Service B	20 (50%)	8 (20%)	8 (20%)	(40)	4 (10%)
	2900	3788	8		4
Service A	4 (45%)	4 (45%)	(8)		
Service C (Balance shared equally)	2	2			(4)
Total	2906	3794			

(b) It would appear that the department is machine intensive so it is preferable to use machine hours. The overhead absorption rate per machine hour is £0.969 (£2906/3000 machine hours).

Chapter 5

5.9 Answer = B

5.10 Answer = D

5.11 The profits in the financial accounts exceed the profits in the cost accounts by £4958 (£79 252 – £74 294). A stock increase represents a reduction in the cost of sales and thus an increase in profits. Therefore the stock increase in the financial accounts must have been £4958 greater than the increase in the cost accounts. The stock increase in the cost accounts was £13 937 (£24 053 – £10 116) so the increase in the financial accounts was £18 895 (£13 937 + £4958). Thus, the closing stock in the financial accounts was £28 112 (£9217 + £18 895).
Answer = D

5.12 In the financial accounts there is a total stock decrease of £2900 (£1000 materials and £1900 finished goods) and a decrease of £3200 in the costs accounts (£1200 materials and £2000 finished goods). Since a stock decrease represents an increase in cost of goods sold and a decrease in profits the cost accounting profit will be £300 less than the financial accounting profit. In other words, the financial accounting profit will be £300 greater than the cost accounting profit.
Answer = A

5.13

	Cost accounts	Financial accounts	Difference
Stock increase	£33 230	£15 601	£17 629

The stock increase shown in the cost accounts is £17 629 more than the increase shown in the financial accounts. Closing stocks represent expenses to be deferred to future accounting periods. Therefore the profit shown in the cost accounts will be £176 129 (£158 500 + £17 629).
Answer = C

5.14 Where substantial costs have been incurred on a contract and it is nearing completion the following formula is often used to determine the attributable profit to date:

$$2/3 \times \text{Notional profit} \times \frac{\text{cash received}}{\text{value of work certified}}$$

$= 2/3 \times (£1.3m - £1m) \times £1.2m/£1.3m = £276\,923$
Answer = B

5.15 Answer = A (Note that if half of the contract is complete the prudence concept advocates that less than half of the profit should be taken).

5.16 Answer = D

5.17 The company's cost accounts are not integrated with the financial accounts. For a description of a non-integrated accounting system see 'Interlocking accounts' in Chapter 5. The following accounting entries are necessary:

Cost ledger control account

	£			£
Sales a/c	410 000	1.5.00	Balance b/f	302 000
Capital under construction a/c	50 150		Stores ledger a/c – Purchases	42 700
Balance c/f	237 500		Wages control a/c	124 000
			Production overhead a/c	152 350
			WIP a/c – Royalty	2 150
			Selling overhead a/c	22 000
			Profit	52 450
	697 650			697 650

Stores ledger control account

		£			£
1.5.00	Balance b/f	85 400		WIP a/c	63 400
	Cost ledger control a/c – Purchases	42 700		Production overhead a/c	1 450
				Capital a/c	7 650
			31.5.X0	Balance c/f	55 600
		£128 100			£128 100

Wages control account

	£		£
Cost ledger control a/c	124 000	Capital a/c	12 500
		Production	35 750
		WIP a/c	75 750
	£124 000		£124 000

Production overhead control account

	£		£
Stores ledger a/c	1 450	Capital a/c	30 000
Wages control a/c	35 750	WIP a/c – Absorption (balancing figure)	152 000
Cost ledger control a/c	152 150	Costing P/L a/c (under absorption)	7 550
	£189 550		£189 550

Work in progress control account

		£			£
1.5.00	Balance b/f	167 350		Finished goods control a/c (balancing figure)	281 300
	Stores ledger a/c – Issues	63 400			
	Wages control a/c	75 750	31.5.X0	Balance c/f*	179 350
	Production overhead absorbed	152 000			
	Cost ledger control a/c – Royalty	2 150			
		£460 650			£460 650

Finished goods control account

		£			£
1.5.00	Balance b/f	49 250		Cost sales a/c*	328 000
	WIP a/c	281 300	31.5.X0	Balance c/f	2 550
		£330 550			£330 550

Capital under construction account

	£		£
Stores ledger a/c	7 650	Cost ledger control a/c	50 150
Wages control a/c	12 500		
Production overhead absorbed	30 000		
	£50 150		£50 150

Sales account

	£		£
Costing P/L a/c	£410 000	Cost ledger control a/c	£410 000

Cost of sales account

	£		£
Finished goods a/c*	£328 000	Cost P/L a/c	£328 000

Selling overhead account

	(£)		(£)
Cost ledger control a/c	122 000	Costing P/L a/c	122 000

Costing profit and loss account

	(£)		(£)
Selling overhead a/c	22 000	Sales a/c	410 000
Production overhead (under absorbed)	7 550		
Cost of sales a/c	328 000		
Profit – Cost ledger control a/c	52 450		
	410 000		410 000

Notes

*Closing balance of work in progress = £167 350 (opening balance) + £12 000 (increase per question) = £179 350

*Transfer from finished goods stock to cost of sales account: £410 000 sales × (100/125) = £328 000

5.18 (a)

Stores ledger control account

	(£)		(£)
Opening balance b/f	24 175	Materials issued:	
Creditors – materials purchased	76 150	Work in progress control	26 350
		Production overhead control	3 280
		Closing stock c/f	70 695
	100 325		100 325

Wages control account

	(£)		(£)
Direct wages:		WIP	15 236
Wages accrued a/c	17 646	Capital equipment a/c	2 670
Employees' contributions a/c	4 364	Factory overhead (idle time)	5 230
Indirect wages:		Factory overhead (indirect wages)	4 232
Wages accrued a/c	3 342		
Employees' contributions a/c	890		
Balances (Wages accrued a/c)	1 126		
	27 368		27 368

Work in progress control account

	(£)		(£)
Opening balance b/f	19 210	Finished goods control – cost of goods transferred	62 130
Stores ledger – materials issued	26 350	Closing stock c/f	24 360
Wages control: direct wages	15 236		
Production overhead control: overhead absorbed (15 236 × 150%)	22 854		
Profit and loss a/c: stock gain*	2 840		
	86 490		86 490

Finished goods control account

	(£)		(£)
Opening balance b/f	34 164	Profit and loss a/c: cost of sales	59 830
Work in progress: cost of goods sold	62 130	Closing stock c/f (difference)	36 464
	96 294		96 294

Production overhead control account

	(£)		(£)
Prepayments b/f	2 103	Work in progress: absorbed overheads (15 236 × 150%)	22 854
Stores ledger: materials issued for repairs	3 280	Capital under construction a/c: overheads absorbed (2670 × 150%)	4 005
Wages control: idle time of direct workers	5 230	Profit and loss a/c: underabsorbed overhead balance	183
Wages control: indirect workers' wages (3342 + 890)	4 232		
Cash/creditors: other overheads incurred	12 200		
	27 042		27 042

Profit and loss account

	(£)		(£)
Cost of goods sold	59 830	Sales	75 400
Gross profit c/f	15 570		
	75 400		75 400
Selling and distribution overheads	5 240	Gross profit b/f	15 570
Production overhead control: underabsorbed overhead	183	Stock gain*: WIP control	2 840
Net profit c/f	12 987		
	18 410		18 410

Note

*The stock gain represents a balancing figure. It is assumed that the stock gain arises from the physical count of closing stocks at the end of the period.

Note that value of materials transferred between batches will be recorded in the subsidiary records, but will not affect the control (total) accounts.

(b) (i) Large increase in raw material stocks. Is this due to maintaining uneconomic stock levels or is it due to an anticipated increase in production to meet future demand?

(ii) WIP stock gain.

(iii) Idle time, which is nearly 25% of the total direct wages cost.

(iv) The gross direct wages are £22 010 (£17 646 + £4364), but the allocation amounts to £23 136 (£15 236 + £5230 + £2670).

(c) Stocks are valued at the end of the period because they represent unexpired costs, which should not be matched against sales for the purpose of calculating profits. Stocks represent unexpired costs, which must be valued for inclusion in the balance sheet.

Manufacturing expense items such as factory rent are included in the stock valuations because they represent resources incurred in transforming the materials into a more valuable finished product. The UK financial accounting regulations (SSAP 9) states that 'costs of stocks (and WIP) should comprise those costs which have been incurred in bringing the product to its present location and condition, including all related production overheads.'

5.19 (a)

Raw materials stores account

	(£)		(£)
Balance b/d	49 500	Work in progress	184 900
Purchases	188 800	Loss due to flood to P&L a/c	2 400
		Balance c/d	51 100
	£238 300		£238 300
Balance b/d	51 100		

Work in progress control account

	(£)		(£)
Balance b/d	60 100	Finished goods	222 500
Raw materials	184 900	Balance c/d	56 970
Direct wages	40 200		
Production overhead	74 370		
	£279 470		£279 470
Balance b/d	56 970		

Finished goods control account

	(£)		(£)
Balance b/d	115 400	Cost of sales	212 100
Work in progress	222 500	Balance c/d	125 800
	£337 900		£337 900
Balance b/d	125 800		

Production overhead

	(£)		(£)
General ledger control	60 900	Work in progress (185% × £40 200)	74 370
Notional rent (3 × £4000)	12 000		
Overhead over absorbed	1 470		
	£74 370		£74 370

General ledger control account

	(£)		(£)
Sales	440 000	Balance b/d (49 500 + 60 100 + 115 400)	225 000
Balance c/d	233 870	Purchases	188 800
		Direct wages	40 200
		Production overhead	60 900
		Notional rent	12 000
		P & L a/c (profit for period: see (b))	226 970
	£673 870		£673 870

(b) *Calculation of profit in cost accounts*

	(£)	(£)
Sales		440 000
Cost of sales	212 100	
Loss of stores	2 400	
Less overhead over absorbed	214 500	
Profit	1 470	213 030
		226 970

Reconciliation statement[a]

	(£)	(£)	(£)
Profit as per cost accounts			226 970
Differences in stock values:			
Raw materials opening stock	1500		
Raw materials closing stock	900		
WIP closing stock	1050	3 450	
WIP opening stock	3800		
Finished goods opening stock	4600		
Finished goods closing stock	2800	(12 400)	(8 970)
Add items not included in financial accounts:			
Notional rent			12 000
Profit as per financial accounts			230 000

Note

•Stock valuations in the financial accounts may differ from the valuations in the cost accounts. For example, raw materials may be valued on a LIFO basis in the cost accounts, whereas FIFO or weighted average may be used in the financial accounts. WIP and finished stock may be valued on a marginal (variable costing) basis in the cost accounts, but the valuation may be based on an absorption costing basis in the financial accounts. To reconcile the profits, you should start with the profit from the cost accounts and consider what the impact would be on the profit calculation if the financial accounting stock valuations were used. If the opening stock valuation in the financial accounts exceeds the valuation in the cost accounts then adopting the financial accounting stock valuation will reduce the profits. If the closing stock valuation in the financial accounts exceeds the valuation in the cost accounts then adopting the financial accounting stock valuation will increase profits. Note that the notional rent is not included in the financial accounts and should therefore be deducted from the costing profit in the reconciliation statement.

(c) The over recovery of overhead could be apportioned between cost of goods sold for the current period and closing stocks. The justification for this is based on the assumption that the under/over recovery is due to incorrect estimates of activity and overhead expenditure, which leads to incorrect allocations being made to the cost of sales and closing stock accounts. The proposed adjustment is an attempt to rectify this incorrect allocation.

The alternative treatment is for the full amount of the under/over recovery to be written off to the cost accounting profit and loss account in the current period as a period cost. This is the treatment recommended by SSAP 9.

5.20 (a) *HR Construction plc – Contract Accounts*

(£000)	A (£000)	B (£000)		A (£000)	B
Stores	700	150	Stores returns	80	30
Plant	1000	150	Transfers to B	40	—
Transfers from A	—	40	Materials c/fwd	75	15
Plant hire	200	30	Plant c/fwd[a]	800	144
Labour	300	270	Cost of work not certified c/fwd	160	20
Overhead	75	18	Balance – Cost of work certified c/fwd	1065	453
Direct expenses	25	4		2300	662
	2300	662			
Cost of work certified b/fwd	1065	453	Attributable sales revenue[c]	1545	420
Profit recognized this period[b]	480		Loss recognized this period[b]		33
	1545	453		1545	453
Cost of work not certified c/fwd	160	20			
Plant b/fwd	800	144			
Materials b/fwd	75	15			

Notes

[a] Value at the start of the year less one year's depreciation for Contract A and 3 months' depreciation for Contract B.

[b] The profits/(losses) recognized for the period are calculated as follows:

	Contract A (£000)	Contract B (£000)
Cost of work certified	1065	453
Cost of work not certified	160	20
Estimated costs to complete	135	110
Estimated cost of the contracts	1360	583
Contract price	2000	550
Estimated profit/(loss)	640	(33)

Profit recognized (Value certified (1500)/Contract price (2000) × £640 = £480 000 for Contract A.
An alternative more prudent approach would have been to multiply the estimated profit by cash received/contract price.
Applying the prudence concept the full anticipated loss is recognized in the current period.
Profit recognized plus cost of work certified for A
Cost of work certified less loss recognized for B.

(b) *Balance sheet extracts*

	Contract A (£000)	Contract B (£000)
Fixed assets		
Plant at cost	1000	150
Depreciation	120	6
Written down value	880	144
Debtors		
Attributable sales	1545	420
Less cash received	1440	460
	105	(40)
Work-in-progress		
Total costs incurred to date	1225	473
Included in cost of sales	1065	453
	160	20

The loss of 33 000 for Contract A will be shown as a deduction from the total company profits. Alternatively, the loss can be deducted from the total costs incurred to date thus reflecting the fact that £33 000 of the total losses have been recognized during the current period.

(c) See 'job costing systems and process costing systems' in Chapter 2 and 'contract costing' in Chapter 5 for the answer to this question.

Chapter 6

6.12 Actual output is 100 units greater than expected so expected output = 2 700 kg
Following the approach described in Chapter 6 the cost per unit is calculated as follows:

$$\frac{\text{Input cost less scrap value of normal loss } (300 \times £3)}{\text{Expected output } (2700 \text{ kg})} = £7.50$$

Initial cost – £900 = (2700 × £7.50 = 20 250)
Initial cost = £21 150
Answer = D

6.13

	Units
Opening stock	400
Input	3000
	3400
Closing stock	(200)
Actual losses (normal + abnormal)	(400)
Output	2800

Answer = A

6.14 The input cost consists of materials of £9000 plus conversion costs of £13 340 giving a total of £22 340.

Cost per unit =

$$\frac{\text{Input cost } (£22\,340) \text{ less scrap value of normal loss } (100 \times £3)}{\text{Expected output } (2000 \times 0.95 = 1900 \text{ units})}$$

= £11.60

Answer = B

6.15 Answer = C

6.16 Completed units (9850) plus closing WIP equivalent units (0.3 × 450) = 9985 units
Answer = D

6.17

	Cost (£)	Units completed	Normal loss equiv. units	Abnormal loss equiv. units	Total equiv. units	Cost per unit (£)
Materials	90 000	36 000	3000 (100%)	1000 (100%)	40 000	2.25
Conversion cost	70 200	36 000	2250 (75%)	750 (75%)	39 000	1.80
						4.05

Cost of abnormal loss:

Materials	1000 × £2.25 =	£2250
Conversion cost	750 × £1.80 =	£1350
		£3600

Answer = A

6.18 Abnormal gain debited to process account and credited to abnormal gain account:

	(£)	(£)
Materials (160 × £9.40)	1504	
Conversion cost (160 × 0.75 × £11.20)	1344	
		2848
Lost sales of scrap (180 × £2)		(360)
Net cost credited to profit and loss account		2528

Answer = C

6.19 Input = Opening WIP (2000 units) + Material input (24 000) = 26 000
Output = Completed units (19 500) + Closing WIP (3000) + Normal Loss (2400) = 24 900
Abnormal Loss = 1100 units (Balance of 26 000 – 24 900)

Equivalent units (FIFO)

	Completed units less Opening WIP equiv. units	Closing WIP equiv. units	Abnormal loss equiv. units	Total equiv. units
Materials	17 500 (19 500 – 2000)	3000 (100%)	1100 (100%)	21 600
Conversion	18 780 (19 500 – 720)	1350 (45%)	1100 (100%)	21 230

It is assumed that losses are detected at the end of the process and that the answer should adopt the short-cut method and ignore the normal loss in the cost per unit calculations.

Answer = C

6.20 Closing stock = Opening stock (Nil) + Input (13 500) – Completed units (11 750) = 1750 units
It is assumed that materials are fully complete (£5.75) and labour and overheads are partly complete (£2.50)
Value of closing stock = (1750 × £5.75) + (1750 × £2.50) = £14 437.50
Answer = B

6.21

Actual input	2500 kg
Normal wastage (10%)	250
Abnormal loss	75
Balance = Good production	2175

Answer = A

6.22 *Equivalent units (FIFO)*

	Completed units less opening WIP equiv. units	Closing WIP equiv. units	Abnormal loss equiv. units[a]	Total equiv. units
Materials	23 800 (24 000 – 1000)	3500	500	27 000
Conversion cost	23 300 (24 000 – 700)	2800 (80%)	300 (60%)	26 400

Note
[a]Total input (30 000 + 1000) – ((30 000 × 10%) + 24 000 + 3500) = 500

It is assumed that the answer should adopt the short-cut method and ignore the normal loss in the cost per unit calculation.
(a) Answer = (iii)
(b) Answer = (i)

6.23 Input = Opening WIP (2400) + Material input (58 000) = 60 400 litres
Output = Completed units (52 500) + Normal loss (5% × 58 000 = 2900) + Closing WIP (3000) = 58 400
Abnormal loss = 60 400 – 58 400 = 2000 litres
It is assumed that the short-cut method described in Appendix 6.1 is adopted whereby the normal loss is not included in the equivalent units calculation. The computation of equivalent units is as follows:

Cost element	Completed units	Abnormal loss equivalent units	Closing WIP equivalent units	Total equivalent units
Materials	52 500	2000	3000	57 500
Conversion cost	52 500	2000	1500	56 000

Answer = D

6.24 (a) The debit side (input) indicates that 4 000 units were input into the process but the output recorded on the credit side is 3850 units thus indicating that the balance must represent an abnormal loss of 150 units. The accounting entries for abnormal losses are to debit the abnormal loss account and credit the process account. Therefore the answer is A.
(b) and (c)
The calculation of the closing WIP value and the cost of finished goods is as follows:

Cost element	Total cost (£)	Completed units	Abnormal loss equivalent units	Closing WIP equivalent units	Total equivalent units	Cost per unit (£)	Closing WIP (£)
Materials[a]	15 300	2750	150	300	3600	4.25	2975.00
Labour	8 125	2750	150	350	3250	2.50	875.00
Production overhead	3 498	2750	150	280	3180	1.10	308.00
	27 923					7.85	4 158.00
					Finished goods (2750 × £7.85)		21 587.50
					Abnormal loss (150 × £7.85)		1 177.50
							27 923.00

Note
[a]£16 000 materials less £700 scrap value of the normal loss. The above computation is based on the short-cut method described in the Appendix of Chapter 6.

Therefore the answer is B for part both parts (b) and (c).

6.25

Completed units less opening WIP equivalent units	4000 (4100 less 40% × 250 units)
Abnormal loss	275
Closing WIP	45 (150 × 30%)
Equivalent units	4320

It is assumed that the short-cut method (see Appendix 6.1) will be used in respect of normal losses.
Answer = C

6.26
Cost per unit of output

$$= \frac{\text{Input cost (£52 500 + £8625 = £2 125) - less expected loss (0.25 × 3500 = £8 = £7000)}}{\text{Expected output (0.75 × 3500)}}$$

= £21

Value of actual output = 2800 × £21 = £58 800
Answer = C
Note that there is an abnormal gain of 175 units (Actual output of 2800 units less expected output of 2625 units)
The debit side of the process account will consist of:

Input cost (3500 kg)	= £62 125
Abnormal gain (175 kg at £21)	= 3 675
	65 800

The following entries will be made on the credit side:

Normal loss (875 kg at £8)	= £7 000
Value of actual output	= £58 800
	£65 500

6.27 (a) *Production statement*

	Input		Output
Opening stock	3 400	Finished stock	36 000
Input	37 000	WIP	3 200
		Normal loss	1 200
	40 400		40 400

Cost statement

	Opening stock (£)	Current cost (£)	Total cost (£)	Completed units (£)	Normal loss (£)	WIP equivalent units (£)	Total equivalent units (£)	Cost per unit (£)	WIP* (£)
Materials	25 500	276 360	301 860	36 000	1200	5280	40 480	7.47	23 664
Conversion cost	20 600	336 000	356 600	36 000	1200	1680	38 880	8.45	15 120
			658 460					16.92	39 024
				Normal loss (1200 × £16.92)			20 304		
				Completed units (36 000 × £16.92)			609 132		629 436
									668 460

The question does not indicate at what stage in the production process the normal loss is detected. It is assumed that the normal loss is detected at the end of the production process, consequently it is not allocated to WIP. Therefore the total cost of production transferred to finished stock is £629 436.

If the short-cut method described in Chapter 6 is adopted and the normal loss equivalent units are excluded from the above unit cost calculations, the closing WIP valuation is £40 240 and the value of completed production is £628 200. This is equivalent to the following calculation, which apportions the normal loss between completed production and WIP on the basis of equivalent production:

	Completed production (£)	WIP (£)
Materials normal loss (1200 × £7.47 = £8964)	8 232 (36 000/39 200)	732 (3300/39 200)
Conversion cost normal loss (1200 × £9.45 = £11 340)	10 857 (36 000/37 600)	483 (1800/37 600)
Normal loss allocation	19 089	1 215
WIP per cost statement		38 024
Completed production	609 112	
	628 201	40 239

(b) The following characteristics distinguish process costing from job costing:

(i) The cost per unit of output with a process costing system is the average cost per unit, whereas job costing traces the actual cost to each individual unit of output.

(ii) Job costing requires that a separate order and job number be used to collect the cost of each individual job.

(iii) With a process costing system, each unit of output is similar, whereas with a job costing system each unit of output is unique and requires different amounts of labour, material and overheads.

(iv) With a job costing system, costs are accumulated for each order and WIP is calculated by ascertaining the costs that have been accumulated within the accounting period. With a process costing system, costs are not accumulated for each order and it is necessary to use the equivalent production concept to value WIP.

(v) With a process costing system, the allocation of costs to cost of goods sold and closing stocks is not as accurate, because each cost unit is not separately identifiable. Consequently WIP is estimated using the equivalent production concept.

6.28 (a)

Cost element	Current period costs (£)	Completed units less opening WIP equiv. units	Closing WIP equiv. units	Current total equiv. units	Cost per unit (£)
Materials	2255	2800	1380	4180	0.55
Conversion costs*	2028	3380	975	4275	0.72
	5333				

	(£)	(£)
Completed production:		
Opening WIP (2540 + £355)	895	
Materials (2800 × £0.55)	1540	
Conversion cost (3380 × £0.72)	2376	
		4811
Closing work in progress:		
Materials (1380 × £0.55)	715	
Conversion cost (975 × £0.72)	702	
		1417
		6228

Note

*Bonus = Current total equivalent units (4275) – Expected output (4000) = 275 units × £0.80 = £220

Labour cost = 6 men × 37 hours × £5 = £1110 + Bonus (£220) = £1330

Conversion cost = £1748 overhead + £1330 labour = £3078

Process account

	(£)		(£)
Opening WIP	895	Completed output	4811
Materials	2255	Closing WIP	1417
Labour and overhead	3078		
	6228		6228

(b) (i) In most organizations the purchasing function is centralized and all goods are purchased by the purchasing department. To purchase goods, user departments complete a purchase requisition. This is a document requesting the purchasing department to purchase the goods listed on the document.

(ii) See 'Materials recording procedure' in Chapter 3 for the answer to this question.

6.29 (a) Opening WIP (100) + input – closing WIP (200) = Normal loss (0.10 × input) + output (1250)

Input – Normal loss (0.10 × input) = 1250 –100 + 200

0.90 input = 1350

Input = 1500 (1350/0.9)

(b) The short cut approach is adopted resulting in the normal loss not being included in the calculation of equivalent units (see Appendix 6.1).

	Completed units less opening WIP equivalent units	Closing WIP equiv. units	Current total equiv. units
Materials	1 150 (1 250 – 100)	200	1 350
Conversion cost	1 220 (1 250 – 30)	80 (200 × 40%)	1 300

(c) Cost per unit = Input cost/current total equivalent units

Conversion cost = 1 300 × £1.50 = £1950

With materials the normal loss will be deducted from the input cost to derive the cost per unit so that:

Materials = 1350 × £2.60 = £3510 + (10% × 1500 × £2) = £3810.

6.30 (a) *Calculation of input for process 1*

	(litres)	(£)
Opening stock	4 000	10 800
Receipts	20 000	61 000
Less closing stock	(8 000)	(24 200)
Process input	16 000	47 600

Output	(litres)
Completed units	8 000
Closing WIP	5 600
Normal loss (15% of input)	2 400
	16 000

Because input is equal to output, there are no abnormal gains or losses.

Calculation of cost per unit (Process 1)

It is assumed that the loss occurs at the point of inspection. Because WIP has passed the inspection point, the normal loss should be allocated to both completed units and WIP.

(1) Element of cost	(2) (£)	(3) Completed units	(4) Normal loss	(5) Closing WIP	(6) Total equiv. units	(7) Cost per unit	(8) = (5) × (7) WIP
Materials	47 600	8000	2400	5600	16 000	£2.975	£16 660
Conversion cost[a]	21 350	8000	1600	4200	14 000	£1.525	£6 405
	68 950					£4.50	£23 065

Note

[a]Conversion cost = direct labour (£4800) + direct expenses (£4270) + overhead (250% × £4800)

Cost of normal loss	(£)
Materials	2400 × £2.975 = 7140
Conversion cost	1600 × £1.525 = 2745
	9885

The apportionment of normal loss to completed units and WIP is as follows:

	Completed units	WIP
Materials	(8000/13 600) × £7140 = £4200	(5600/13 600) × £7140 = £2940
Conversion	(8000/12 200) × £2745 = £1800	(4200/12 000) × £2746 = £945
	£6000	£3885

The cost of completed units and WIP is as follows:

		(£)	(£)
Completed units:	8000 units × £4.50	36 000	
	Share of normal loss	6 000	42 000
WIP:	Original allocation	23 065	
	Share of normal loss	3 885	26 950
			68 950

For an explanation of the above procedure see Appendix 6.1.

Where the normal loss is apportioned to WIP and completed units, a simple (but less accurate) approach is to use the short-cut approach and not to include the normal loss in the unit cost statement. The calculation is as follows:

Element of cost	(£)	Completed units	Closing WIP	Total equiv. units	Cost per unit (£)	WIP (£)
Materials	47 600	8000	5600	13 600	3.50	19 600
Conversion cost	21 350	8000	4200	12 200	1.75	7 350
					5.25	26 950

Completed units 8000 × 5.25 = 42 000

Process 1 account – May 2000

	(litres)	(£)		(litres)	(£)
Materials	16 000	47 600	Transfers to process 2	8 000	42 000
Labour		4 800	Normal loss	2 400	—
Direct expenses		4 270	Closing stock C/f	5 600	26 950
Overheads absorbed		12 280			
	16 000	68 950		16 000	68 950

With process 2, there is no closing WIP. Therefore it is unnecessary to express output in equivalent units. The cost per unit is calculated as follows:

$$\frac{\text{cost of production less scrap value of normal loss}}{\text{expected output}} = \frac{£54\,000^{a}}{(60\% \times 8000)} = £7.50$$

Note

[a]Cost of production = transferred in cost from process 1 (42 000) + labour (£6000) + overhead (£6000).

Process 2 account – May 2000

	Litres	(£)		Litres	(£)
Transferred from Process 1	8000	42 000	Finished goods store[a]	7500	56 250
Labour		6 000	Normal loss	800	
Overheads absorbed		6 000	Closing stock	—	—
Abnormal gain[a]	300	2 250			
	8300	56 250		8300	56 250

Finished goods account

	Litres	(£)
In Process 2	7500	56 250

Abnormal gain account

	(£)		Litres	(£)
Profit and loss account	2250	Process 2 account	300	2250

Note

[a]Input = 8000 litres. Normal output = 90% × 8000 litres = 7200 litres. Actual output = 7500 litres. Abnormal gain = 300 litres × £7.50 per litre = £2250.

[b]7500 litres at £7.50 per litre.

(b) If the materials can be replaced then the loss to the company will consist of the replacement cost of materials. If the materials cannot be replaced then the loss will consist of the lost sales revenue less the costs not incurred as a result of not processing and selling 100 litres.

Chapter 7

7.11

	(£)
Joint costs apportioned to P (4500/9750 × £117 000) =	54 000
Further processing costs (4500 × £9) =	40 500
Total cost	94 500
Sales revenues (4050 × £25)	101 250
Profit	6 750

Answer = A

7.12 Answer = D

7.13 Total sales revenue = £1 080 000 (£18 × 10 000 + £25 × 20 000 + £20 × 20 000)

Joint costs to be allocated = £270 000 (277 000 total output cost – £2 × 3500 by-product sales revenue)

Costs allocated to product 3 = 270 000 × (£20 × 20 000)/£1 080 000 = £100 000

Unit cost of product 3 = £5 per unit (£100 000/20 000 units)

Answer = C

7.14 (a) Output = 12 500kg input less 20% normal loss = 10 000 kg.

Input costs = £102 000 (£45 625 + £29 500 + 26 875)

$$\text{Cost per unit} = \frac{\text{Input cost less scrap value of normal loss } (2500 \times £4)}{\text{Expected output } (10\,000 \text{ kg})}$$

= £9.20

Total cost of output = £92 000 (10 000 × £9.20)

(b) Joint costs to be allocated = £92 000 – by-product income (10 000 × 0.10 × £2) = £90 000

Product	Units	%	NRV at split-off	Total NRV	Joint cost allocation		Total profit	Profit per unit
A	5 000	50	10(20–10)	50 000	30 000	[50 000/150 000]	20 000	4
B	4 000	40	25	100 000	60 000	[100 000/150 000]	40 000	10
C	1 000	10	2					
Total	10 000	100		150 000	90 000			

The profit per unit for product A is £4 and for B is £10.

7.15 (a)

	Product X (£)	Material B (£)
Apportionment of joint costs (W1)	35 400	106 200
Further processing costs	18 000	—
	53 400	106 200
Sales (W2)	50 400	180 000
Profit/(loss)	(3 000)	73 800
Profit/(loss) per kg (W3)	(0.33)	2.46

Workings:

(W1) X = (£141 600/40 000 kg) × 10 000 kg

B = (£141 600/40 000 kg) × 30 000 kg

(W2) X = 9000 kg at £5.60, B = 30 000 × £6

(W3) X = £3000/9000 kg, B = £73 800/30 000 kg

(b) The answer should stress that a joint products costs cannot be considered in isolation from those of other joint products. If product X was abandoned the joint costs apportioned to X would still continue and would have to be absorbed by material B. Therefore no action should be taken on product X without also considering the implications for material B. Note that the process as a whole is profitable. The decision to discontinue product X should be based on a comparison of those costs which would be avoidable if X were discontinued with the lost sales revenue from product X. Joint costs apportionments are appropriate for stock valuation purposes but not for decision-making purposes.

(c) An alternative method is to apportion joint costs on the basis of net realizable value at split-off point. The calculations are as follows:

	Sales value	Costs beyond split-off point	Net realizable value at split-off point	Joint cost apportionment
Product X	50 400	18 000	32 400	21 600 (W1)
Material A	180 000	—	180 000	120 000 (W2)
			212 400	141 600

Workings

(W1) (£32 400/£212 400) × £141 600

(W2) (£180 000/£212 400) × £141 600

The revised profit calculation for product X is:

		(£)
Sales		50 400
Less Joint costs	21 600	
Processing costs	18 000	39 600
Profit		10 800
Profit per kg		£1.20 (£10 800/9000 kg)

Apportionment methods based on sales value normally ensure that if the process as a whole is profitable, then each of the joint products will be shown to be making a profit. Consequently it is less likely that incorrect decisions will be made.

7.16 (a) See Chapters 6 and 7 for an explanation of the meaning of each of these terms.

(b) No specific apportionment method is asked for in this problem. It is recommended that the joint costs should be apportioned (see Chapter 7) according to the sales value at split-off point:

Product	Sales value (£)	Proportion to total (%)	Joint costs apportioned (£)
A	60 000	20	40 000
B	40 000	13.33	26 660
C	200 000	66.67	133 340
	300 000	100.00	200 000

(c) Assuming all of the output given in the problem can be sold, the initial process is profitable – the sales revenue is £300 000 and the joint costs are £200 000. To determine whether further processing is profitable the additional revenues should be compared with the additional relevant costs:

	A (£)	B (£)	C (£)
Additional relevant revenues	10 (20–10)	4 (8–4)	6 (16–10)
Additional relevant costs	14	2	6
Excess of relevant revenue over costs	(4)	2	–

Product B should be processed further, product A should not be processed further, and if product C is processed further, then profits will remain unchanged.

7.17 (a) Operating statement for October 2000

	(£)	(£)
Sales: Product A (80 000 × £5) =	400 000	
Product B (65 000 × £4) =	260 000	
Product C (75 000 × £9) =	675 000	1 335 000
Operating costs	1 300 000	
Less closing stock*	200 000	
		1 100 000
Profit		235 000

Note
*Production for the period (kg):

	A	B	C	Total
Sales requirements	80 000	65 000	75 000	
Closing stock	20 000	15 000	5 000	
Production	100 000	80 000	80 000	260 000

Therefore

Closing stock = 40 000 kg at £5 per kg

(b) Evaluation of refining proposal

	A	B	C	Total (£)
Incremental revenue per kg (£)	12	10	11.50	
Variable cost per kg (£)	4	6	12.00	
Contribution per kg (£)	8	4	(0.50)	
Monthly production (kg)	100 000	80 000	80 000	
Monthly contribution (£)	800 000	320 000	(40 000)	1 080 000
Monthly fixed overheads (specific to B)		360 000		360 000
Contribution to refining general fixed costs (£)	800 000	(40 000)	(40 000)	720 000
Refining general fixed overheads				700 000
Monthly profit				20 000

1. It is more profitable to sell C in its unrefined state and product B is only profitable in its refined state if monthly sales are in excess of 90 000 kg (£360 000 fixed costs/£4 contribution per unit).
2. If both products B and C are sold in their unrefined state then the refining process will yield a profit of £100 000 per month (£800 000 product A contribution less £700 000 fixed costs).
3. The break-even point for the refining process if only product A were produced is 87 500 kg (£700 000 fixed costs/£8 contribution per unit). Consequently if sales of A declined by 12½%, the refining process will yield a loss. Note that 80 000 kg of A were sold in October.

Chapter 8

8.9 Fixed overhead = £2 per unit (£60 000/30 000 units)
Because production exceeded sales by 180 units a sum of £360 (180 × £2) is included in the stock valuation and not charged as an expense of the current period. Fixed overheads of £4640 (£5000 monthly cost – £360) are therefore charged as an expense for the period.

	(£)
Contribution (2220 units sales × £5.50)	12 210
Fixed overheads charged as an expense	4 640
Profit	7 570

Answer = B

8.10 Because closing inventory exceeds opening inventory, production exceeds sales so that absorption costing will be greater than the marginal costing profit by the amount of fixed overheads included in the increase in inventories. Therefore the absorption profit is:
Marginal costing profit (37 500) + fixed overheads included in the increase in inventories (£4 × 250 units) = £38 500.
Answer = C

8.11 Contribution = £4 per unit (£10 selling price – £6 variable cost)
Profit = Total contribution (250 000 × £4) – fixed costs (200 000 × £2) = £600 000
Answer = B

8.12 (a) Fixed overheads per unit = $15 000/10 000 units = $1.50
Production exceeds sales so that absorption costing will be greater than the marginal costing profit by the amount of fixed overheads included in the increase in inventories. Therefore the absorption profit will exceed the marginal costing profit by $750 (500 units × $1.50).
Answer = (iii)

(b)

	$	$
Sales (10 300 × $6.40)		65 920
Cost of sales:		
Variable costs (10 300 × $3.60)	37 080	
Fixed overheads (10 300 × $1.50)	15 450	
	52 530	
Under-absorbed fixed overheads ($15 700 – $15 000)	700	53 230
Profit		12 690

Answer = (ii)

8.13 Stocks have increased by 2500 units thus resulting in fixed overheads of £20 000 (2500 units at £8) being absorbed in the stock movements with the absorption costing system. Therefore the absorption costing system will record £20 000 less than the fixed overheads incurred for the period. In other words, the marginal costing system will record £20 000 more fixed costs resulting in profit of £22 000 being reported.
Answer = B

8.14 The profit difference is due to the fixed overheads being incorporated in the stock movements with the absorption costing system.
Profit difference = £9750 (£60 150 – £50 400)
Fixed overheads in stock movement = £9750
Physical stock movement = 1500 units
Fixed overhead rate per unit = £9750/1500 units = £6.50
Answer = D

8.15 Answer = B (unavoidable costs are not relevant for decision-making and the remaining statements are correct).

8.16 (a) Fixed production overhead per unit = £3 (£300 000/100 000 units)

Absorption costing	£000	£000
Sales (£50 × 100 000)		5000
Cost of sales:		
Opening stock	–	
Production costs		
Variable (£19 × 120 000)	2280	
Fixed (£3 × 120 000)	360	
	2640	
Closing stock (£22 × 20 000)	(440)	
Over-absorption (20 000 units × £3)	(60)	
		(2140)
Gross profit		2860
Selling costs		
Fixed		(150)
Variable (£2 × 100 000)		(200)
Net profit		2510

(b)

Marginal costing	£000	£000
Sales (£50 × 100 000)		5000
Cost of sales:		
Opening stock	—	
Production costs		
Variable (£19 × 120 000)	2280	
	2280	
Closing stock (£19 × 20 000)	(380)	
Variable selling costs	200	
		(2100)
Contribution		2900
Fixed costs		
Production		(300)
Selling		(150)
Net profit		2450

8.17

	£
Calculation of product cost:	
Materials	10
Labour	2
Variable production cost	12
Variable distribution cost	1
Total variable cost	13
Fixed overhead (£10 000/1000 units)	10
Total costs	23

The product costs for stock valuation purposes are as follows:

Variable costing £12 (variable production cost)

Absorption costing £22 (variable production cost + fixed manufacturing overhead)

It is assumed that all of the fixed overhead relates to production. Note that the distribution cost is per unit *sold* and not per unit *produced*.

(a) (i) *Variable costing*

	t_1	t_2	t_3
Opening stock	1 200	1 200	1 200
Production	12 000	12 000	12 000
	13 200	13 200	13 200
Closing stock	1 200	1 200	1 200
Cost of sales	12 000	12 000	12 000
Sales at £25 per unit	25 000	25 000	25 000
Gross profit	13 000	13 000	13 000
Distribution costs	1 000	1 000	1 000
Fixed labour costs	5 000	5 000	5 000
Fixed overhead costs	5 000	5 000	5 000
Net profit	£2 000	£2 000	£2 000

Total profit £6000

Absorption costing

	t_1 (£)	t_2 (£)	t_3 (£)
Opening stock	2 200	2 200	2 200
Production	22 000	22 000	22 000
	24 200	24 200	24 200
Closing stock	2 200	2 200	2 200
Cost of sales	22 000	22 000	22 000
Sales at £25 per unit	25 000	25 000	25 000
Gross profit	3 000	3 000	3 000
Distribution cost	1 000	1 000	1 000
Net profit	£2 000	£2 000	£2 000

Total profit £6000

(ii) *Variable costing*

	t_1 (£)	t_2 (£)	t_3 (£)
Opening stock	1 200	7 200	4 800
Production	18 000	9 600	8 400
	19 200	16 800	13 200
Closing stock	7 200	4 800	1 200
Cost of sales	12 000	12 000	12 000
Sales at £25 per unit	25 000	25 000	25 000
Gross profit	13 000	13 000	13 000
Distribution costs	1 000	1 000	1 000
Fixed labour costs	5 000	5 000	5 000
Fixed overhead costs	5 000	5 000	5 000
Net profit	£2 000	£2 000	£2 000

Total profit £6000

Absorption costing

	t_1 (£)	t_2 (£)	t_3 (£)
Opening stock	2 200	13 200	8 800
Production	33 000	17 600	15 400
	35 200	30 800	24 200
Under/(over) recovery	(5 000)	2 000	3 000
	30 200	32 800	27 200
Closing stock	13 200	8 800	2 200
Cost of sales	17 000	24 000	25 000
Sales at £25 per unit	25 000	25 000	25 000
Gross profit	8 000	1 000	—
Distribution cost	1 000	1 000	1 000
Net profit	£7 000	—	£(1 000)

Total profit £6 000

(iii) *Variable costing*

	t_1 (£)	t_2 (£)	t_3 (£)
Opening stock	1 200	7 200	4 800
Production	12 000	12 000	12 000
	13 200	19 200	16 800
Closing stock	7 200	4 800	1 200
Cost of sales	6 000	14 400	15 600
Sales at £25 per unit	12 500	30 000	32 500
Gross profit	6 500	15 600	16 900
Distribution costs	500	1 200	1 300
Fixed labour costs	5 000	5 000	5 000
Fixed overhead costs	5 000	5 000	5 000
Net profit	£(4 000)	£4 400	£5 600

Total profit £6000

Absorption costing

	t_1 (£)	t_2 (£)	t_3 (£)
Opening stock	2 200	13 200	8 800
Production	22 000	22 000	22 000
	24 200	35 200	30 800
Closing stock	13 200	8 800	2 200
Cost of sales	11 000	26 400	28 600
Sales at £25 per unit	12 500	30 000	32 500
Gross profit	1 500	3 600	3 900
Distribution cost	500	1 200	1 300
Net profit	£1 000	£2 400	£2 600

Total profit £6000

(b) For the answer to this question see Chapter 8: Note that profits are identical for both systems in (i), since production equals sales. In (ii) and (iii) profits are higher with absorption costing when production exceeds sales, whereas profits are higher with variable costing when production is less than sales. Taking the three periods as a whole there is no change in the level of opening stock in t_1 compared with the closing stock in t_3, so that the disclosed profit for the three periods is the same under both systems. Also note that the differences in profits disclosed in (a) (ii) and (a) (iii) is accounted for in the fixed overheads included in the stock valuation changes.

Chapter 9

9.11 Answer = C

9.12 BEP = Fixed costs/PV ratio
PV ratio = Contribution/Sales = £275 000/£500 000 = 0.55
BEP = £165 000/0.55 = £300 000
Answer = D

9.13 Required sales revenue = $\frac{\text{Fixed costs (£75 000)} + \text{Target profit (£150 000)}}{\text{PV ratio (0.75)}}$
= £300 000
Units of output = £300 000/£10 unit selling price
= 30 000 units
Answer = D

9.14 Budgeted total contribution = £125 000 (5000 units × £25)
The margin of safety is positive thus indicating a budgeted profit. Therefore fixed costs must be less than £125 000 for a budgeted profit to occur. Only one of the potential items (item A) meets this requirement.
Answer = A

9.15 Average contribution to sales ratio = $\frac{(40\% \times 1) + (50\% \times 3)}{4} = 47.5\%$

Break-even point is at the point where 47.5% of the sales equal the fixed costs (i.e. £120 000/0.475 = £252 632).

In other words, the break-even point = $\frac{\text{Fixed costs}}{\text{PV ratio}}$

Answer = C

9.16 Contribution/sales (%) = (0.33 × 40% Aye) + (0.33 × 50% Bee) + (0.33 × ? Cee) = 48%
Cee = 54% (Balancing figure)
The total contribution/sales ratio for the revised sales mix is: (0.40 × 40% Aye) + (0.25 × 50% Bee) + (0.35 × 54% Cee) = 47.4%
Answer = C

9.17

Sales	100	110 (100 + 10%)
Variable cost	60	60
Contribution	40	50

Increase = 25%
Answer = D

9.18 Items (i) and (ii) will reduce variable costs and thus increase the contribution/sales ratio. Item (iii) will result in a reduction in selling price and the c/s ratio whereas it is assumed that with item (iv) that sales to other countries will be at a higher selling price thus resulting in a higher average contribution and c/s ratio. The reduction in selling price for item (v) will result in a reduced contribution and lower ratio. Therefore items (i), (ii) and (iv) will result in an increase in the ratio.
Answer = B

9.19

Break-even point in sales value	=	Fixed costs (£76 800)/ Profit–volume ratio (i.e. contribution/sales ratio)
	=	£76 800/(0.40)
	=	£192 000
Actual sales	=	£224 000
Margin of safety	=	£32 000 (in sales revenues)
Margin of safety in units	=	£2000 (£32 000/£16)

Answer = A

9.20 (a) Budgeted contribution per unit = $11.60 – $3.40 – (5% × $11.60) = $7.62
Break-even point (units) = ($430 500 + 198 150)/$7.62 = 82 500 units
Break-even point (sales value) = 82 500 × $11.60 = $957 000
Budgeted sales = $1 044 000 (90 000 × $11.60)
Margin of safety ($) = $1 044 000 – $957 000 = $87 000
Margin of safety (%) = $87 000/$1 044 000 = 8.33%
Answer = B

(b) Budgeted contribution per unit = $12.25 – $3.40 – (8% × $12.25) = $7.87
Break-even point (units) = ($430 500 + 198 150)/$7.87 = 79 879 units
Answer = C

9.21 (a) Answer = A

(b) The increase in fixed costs will result in an increase in the break-even point. The only correct alternative that is listed is item C. This indicates an increase in the break-even point sales value.

9.22 (a) An increase in fixed costs will result in a lower break-even point (i.e. the number of units sold to break even). Therefore t will decrease.
Answer = (iii)

(b) The slope of the profit line is represented by the change in contribution per unit. The diagram indicates that sales are 800 units in excess of the break-even point (represented by t) and these 800 units generate a profit of $16 000 (represented by W). Profit is equal to contribution above the break-even point so the contribution per unit is $20 ($16 000/800 units). Additional sales can thus be expected to generate an additional contribution and profit of $28 000 (1400 units × $20).
Answer = (iii)

9.23 (i) p = total sales revenue
q = total cost (fixed cost + variable cost)
v = total variable cost
x = fixed costs at the specific level of activity
l = total loss at the specific level of activity
a = total profit at that level of activity
v = total contribution at the specific level of activity
w = total contribution at a lower level of activity
x = level of activity of output sales
y = monetary value of cost and revenue function for level of activity

(ii) At event m the selling price per *unit* decreases, but it remains constant. Note that p is a straight line, but with a lower gradient above m compared with below m.

At event n there is an increase in fixed costs equal to the dotted line. This is probably due to an increase in capital expenditure in order to expand output beyond this point. Also note that at this point the variable cost per unit declines as reflected by the gradient of the variable cost line. This might be due to more efficient production methods associated with increased investment in capital equipment.

(iii) Break-even analysis is of limited use in a multi-product company, but the analysis can be a useful aid to the management of a small single product company. The following are some of the main benefits:

(a) Break-even analysis forces management to consider the functional relationship between costs, revenue and activity, and gives an insight into how costs and revenue change with changes in the level of activity.

(b) Break-even analysis forces management to consider the fixed costs at various levels of activity and the selling price that will be required to achieve various levels of output.

You should refer to Chapter 9 for a discussion of more specific issues of break-even analysis. Break-even analysis can be a useful tool, but it is subject to a number of assumptions that restrict its usefulness (see, especially, 'Cost–volume–profit analysis assumptions').

9.24 *Preliminary calculations:*

	Sales (units)	Profit/(loss)
November	30 000	£40 000
December	35 000	£60 000
Increase	5 000	£20 000

An increase in sales of 5000 units increases contribution (profits) by £20 000. Therefore contribution is £4 per unit. Selling price is £10 per unit (given) and variable cost per unit will be £6.

At £30 000 unit sales:

Contribution minus Fixed costs = Profit
£120 000 minus ? = £40 000
∴ Fixed costs = £80 000

The above information can now be plotted on a graph. A break-even chart or a profit–volume graph could be constructed. A profit–volume graph avoids the need to calculate the profits since the information can be read directly from the graph. (See Figure 1 for a break-even chart and Figure 2 for a profit–volume graph.)

(a) (i) Fixed costs = £80 000.
(ii) Variable cost per unit = £6.
(iii) Profit–volume = $\frac{\text{Contribution per unit (£4)}}{\text{Selling price per unit (£10)}} \times 100 = 40\%$
(iv) Break-even point = 20 000 units.
(v) The margin of safety represents the difference between actual or expected sales volume and the break-even point. Therefore the margin of safety will be different for each month's sales. For example, the margin of safety in November is 10 000 units (30 000 units – 20 000 units). The margin of safety can be read from Figure 2 for various sales levels.

(b) and (c) See the sections on 'The accountants' cost–volume–profit model' and 'Cost–volume–profit analysis assumptions' in Chapter 9 for the answers.

FIGURE 1 *Break-even chart*

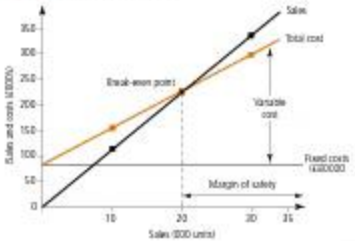
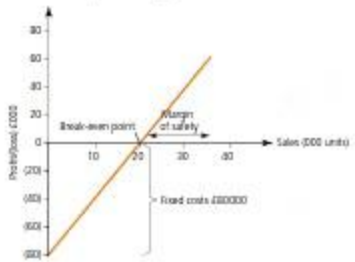


FIGURE 2 *Profit–volume graph*



9.25 (a)

	August (£)	September (£)	Change (£)
Sales	80 000	90 000	10 000
Cost of sales	50 000	55 000	5 000
Selling and distribution	8 000	9 000	1 000
Administration	15 000	15 000	Nil

The only activity measure that is given is sales revenue. An increase in sales of £10 000 results in an increase in cost of sales of £5000 and an increase in selling and distribution costs of £1000. It is therefore assumed that the increase is attributable to variable costs and variable cost of sales is 50% of sales and variable selling and distribution costs are 10% of sales.

Fixed costs are derived by deducting variable costs from total costs for either month. The figures for August are used in the calculations below:

	Total cost (£)	Variable cost (£)	Fixed cost (Balance) (£)
Cost of sales	50 000	40 000	10 000
Selling and distribution	8 000	8 000	Nil
Administration	15 000	Nil	15 000
			25 000

Total cost = £25 000 fixed costs + variable costs (60% of sales)

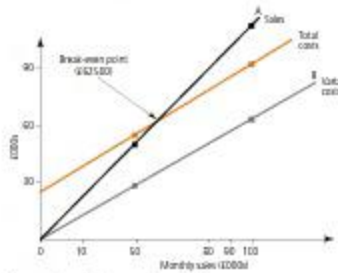
(b) The following items are plotted on the graph (Figure 3):

	Variable cost	Total cost
Zero sales	Nil	£25 000 fixed cost
£80 000 sales	£48 000 (60%)	£73 000
£90 000 sales	£54 000 (60%)	£79 000
£50 000 sales	£30 000 (60%)	£55 000
£100 000 sales	£60 000	£85 000

Break-even point

$$= \frac{\text{Fixed costs (£25 000)}}{\text{Contribution to sales ratio (0.40)}} = £62\,500 \text{ sales}$$

FIGURE 3 *Contribution break-even graph*



Area of contribution = Area AOB

(c)

		(£)
Actual sales = 1.3 × Break-even sales (£62 500)	=	81 250
Contribution (40% of sales)	=	32 500
Fixed costs	=	25 000
Monthly profit	=	7 500
Annual profit	=	90 000

(d)

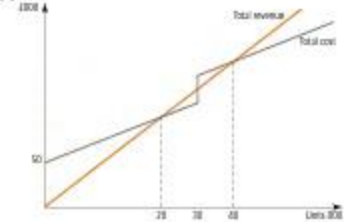
		(£)
Annual contribution from single outlet (£32 500 × 12)	=	390 000
Contribution to cover lost sales (10%)	=	39 000
Specific fixed costs	=	100 000
Total contribution required		529 000

Required sales = £529 000/0.4 = £1 322 500

(e) The answer should draw attention to the need for establishing a sound system of budgeting and performance reporting for each of the different outlets working in close conjunction with central office. The budgets should be merged together to establish a master budget for the whole company.

9.26 (a) Let x = number of units of output
Total cost for 30 000 units or less = £50 000 + 5x (where 5 = variable cost per unit)
Total cost for more than 30 000 units = £100 000 + 5x

(b)



(c) There are two break-even points resulting in the production plan being profitable only between 20 000 and 30 000 units and above 40 000 units. The production plan should be set based on these considerations.

9.27

$$\text{Break-even point} = \frac{\text{Fixed costs}}{\text{Contribution per unit}}$$

Product X	25 000 units (£100 000/£4)
Product Y	25 000 units (£200 000/£8)
Company as a whole	57 692 units (£300 000/£5.20*)

Note:
*Average contribution per unit

$$= \frac{(70\,000 \times £4) + (30\,000 \times £8)}{100\,000 \text{ units}}$$

$$= £5.20$$

The sum of the product break-even points is less than the break-even point for the company as a whole. It is incorrect to add the product break-even points because the sales mix will be different from the planned sales mix. The sum of the product break-even points assumes a sales mix of 50% to X and 50% to Y. The break-even point for the company as a whole assumes a planned sales mix of 70% to X and 30% to Y. CVP analysis will yield correct results only if the planned sales mix is equal to the actual sales mix.

9.28

Workings:	(000)
Sales	1000
Variable costs	600
Contribution	400
Fixed costs	500
Profit/(loss)	(100)

Unit selling price = £20 (£1m/50 000)
Unit variable cost = £12 (£600 000/50 000)
Unit contribution = £8

(a) Sales commission will be £2 per unit, thus reducing the contribution per unit to £6. The break-even point will be 83 333 units (£500 000/£6) or £1 666 666 sales value. This requires an increase of 67% on previous sales and the company must assess whether or not sales can be increased by such a high percentage.

(b) A 10% decrease in selling price will decrease the selling price by £2 per unit and the revised unit contribution will be £6:

	(£)
Revised total contribution (65 000 × £6)	390 000
Less fixed costs	500 000
Profit/(loss)	(110 000)

The estimated loss is worse than last year and the proposal is therefore not recommended.

(c) Wages will increase by 25% – that is, from £200 000 to £250 000 – causing output to increase by 20%.

		(£)
Sales		1 200 000
Direct materials and variable overheads	480 000	
Direct wages	250 000	730 000
Contribution		470 000
Less fixed costs		550 000
Profit/(loss)		(80 000)

This represents an improvement of £20 000 on last year's loss of £100 000.

(d) Revised selling price = £24

Let X = Revised sales volume

∴ sales revenue less (variable costs + fixed costs)	= Profit
24X less (12X + 800 000)	= 0.1 (24X)
∴ 9.6X	= 800 000
∴ X	= 83 333 units

Clearly this proposal is preferable since it is the only proposal to yield a profit. However, the probability of increasing sales volume by approximately 67% plus the risk involved from increasing fixed costs by £300 000 must be considered.

Chapter 10

10.11

Low	650 patients	$17 125
High	1260 patients	18 650
Difference	610 patients	1 525

Variable cost per patient = $1525/610 = $2.50
Total fixed cost using 650 patients = Total cost ($17 125) – variable cost (650 × $2.50) = $15 500
Estimated cost for 850 patients = Variable costs (850 × $2.50) + $15 500 = $17 625
Answer = C

10.12 It is assumed that advertising generates sales. Therefore advertising is the independent variable and sales revenue the dependent variable. The lowest value of the independent variable is £2500 and the highest is £6500. An increase in advertising expenditure of £4000 (6.5 – 2.5) results in additional sales revenue of £100 000 so that each £1 sales results in additional sales of £25. Based on £6500 advertising the sales revenue is £162 500 (6500 × £25) so the balance £62 500 (£225 000 – £162 500) represents the non-variable element. Therefore sales revenue = £62 500 + (£25 × advertising expenditure)
Answer = A

10.13 An increase in activity of 5000 units results in an increase in costs of £150 000 so that the variable element is £30 per unit (£150 000/5000 units).
Answer = B

10.14

	Hours	$
High	5800	23 000
Low	3250	15 350
change	2550	7 650

Variable charge per hour = $3 ($7650/2550)
At 5800 hours the variable cost is $17 400 and the total cost is $23 000 giving a fixed cost of $5600. In period 5 the estimated variable cost is $18 150 (5500 × 1.10 × $3) and the fixed cost is $5880 ($5600 × 1.05). Therefore the estimated total cost is $24 030.
Answer = B

10.15 Estimated variable costs at 500 units:

	£
Direct costs	7500
Production overheads (50%)	500
Selling costs (80%)	1000
	9000

Variable cost per unit = £18.00 (£9000/500 units)
Total costs for 1000 units = £18 000 (1000 × £18.00)
variable + fixed production (£500) + fixed selling (£250) = £18 750.
Profit = Sales revenue £35 000 – £18 750 total costs = £16 250
Answer = B

10.16 Formulae 10.4 and 10.5 (see Chapter 10) were given in the examination for this question. Applying formula 10.5:

$$b = \frac{(11 \times 13\,467) - (440 \times 330)}{(11 \times 17\,986) - (440)^2}$$

$$= 0.6917$$

Applying formula 10.4
a = (330/11) – (0.6917 × 440)/11 = 2.33
Answer = C

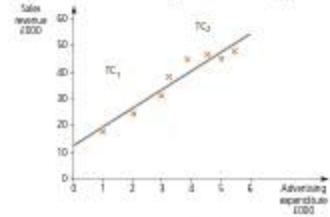
10.17 It is assumed that advertising generates sales. Therefore advertising is the independent variable and sales revenue the dependent variable. Appling formula 10.5 (see Chapter 10) which was provided in the examination paper:

$$b = \frac{(6 \times 447\,250\,000) - (13\,500 \times 192\,000)}{(6 \times 32\,150\,000) - (13\,500)^2} = 8.714$$

Answer = C

10.18 Applying formula 10.4:
a = (200/4) – (17.14 × 5.75)/4 = 25.36
Answer = A

10.19 (a) Advertising expenditure is the independent variable (x) and sales revenue the dependent variable (y).



(b) Formulae 10.4 and 10.5 (see Chapter 10) were given in the examination for this question. Applying formula 10.5:

$$b = \frac{(8 \times 1055.875) - (26.35 \times 289.5)}{(8 \times 101.2625) - (26.35)^2}$$

$$= 818.675/115.7775 = 7.07$$

Applying formula 10.4
a = (289.5/8) – (7.07 × 26.35)/8 = 12.9
Therefore the regression line is y = 12.9 + 7.07x
where x and y are expressed in £000s. The line of best fit is shown in the graph in (a)

10.20 (a) (i) *High- and low-point method*

	Machine hours 000s	Fuel oil expenses (£000's)
High point (June 2000)	48	680
Low point (January 2000)	26	500
Difference	22	180

Variable cost per machine hour £8.182 (£180/22)
Substituting for January 2000

	(£000's)
Variable cost (26 × £8.182) =	212.73
Fixed Cost (difference)	287.27
Total cost	500.00

The total cost equation is y = 287.27 + 8.182x

(ii) *Least-squares regression method*

	Hours x	Fuel oil y	x^2	xy
July	34	640	1 156	21 760
August	30	620	900	18 600
September	34	620	1 156	21 080
October	39	590	1 521	23 010
November	42	500	1 764	21 000
December	32	530	1 024	16 960
January	26	500	676	13 000
February	26	500	676	13 000
March	31	530	961	16 430
April	35	550	1 225	19 250
May	43	580	1 849	24 940
June	48	680	2 304	32 640
	Σx = 420 = 35	Σx = 6840 = 570	Σx^2 = 15 212	Σxy = 241 670

$$\Sigma y = Na + b\Sigma x \quad (1)$$

$$\Sigma xy = \Sigma ax + b\Sigma x^2 \quad (2)$$

Substituting from the above table:

$$6840 = 12a + 420b \quad (1)$$
$$241\,670 = 420a + 15\,212b \quad (2)$$

Multiply equation (1) by 35 (= 420/12):

$$239\,400 = 420a + 14\,700 \quad (3)$$

Subtract equation (3) from equation (2):

$$2270 = 512b, \text{ and so } b = 2270/512 = 4.4336$$

Substitute in equation (1), giving

$$6840 = 12a + 420 \times 4.4336, \text{ so } a = \frac{6840 - 1862.112}{12}$$
$$= 414.824$$
$$y = 414.82 + 4.43x$$

(b) For the answer to this question see Chapter 10.

(c) An r^2 calculation of 0.25 means that 75% of the total variation of y from its mean is not caused by variations in x (machine hours). This means that a large proportion of changes in fuel oil expenses do not result from changes in machine hours. The cost must depend on factors other than machine hours. Other measures of activity might be examined in order to test whether they are closely related to changes in costs. If other measures do not yield a close approximation then this might indicate that cost is dependent on several variables. In these circumstances multiple regression techniques should be used.

Chapter 11

11.12 (a)

	X	Y	Z	Total
Demand (units)	4 000	5 500	7 000	
Materials (kg)	20 000	22 000	42 000	84 000
Labour (hours)	4 000	4 125	10 500	18 625

Labour is the limiting factor.
Answer = (i)

(b)

	X	Y	Z
	$	$	$
Selling price	28	22	30
Variable cost	17	13	24
Contribution	11	9	6
kg	5	4	6
Contribution per kg ($)	2.20	2.25	1
Ranking	2	1	3

Answer = (iv)

11.13 Based on the contribution per limiting factor (materials) the rankings are products (iii), (ii) and (i). Minimum demand requirements for product (i) = 8000 kg leaving a balance of 27 000 kg to be allocated as follows:
Product (iii) maximum demand = 2000
Product (ii) maximum output from the unallocated materials = 3000 units (15 000kg/5kg)
Answer = B (with a minimum demand of 1000 units for product (i).

11.14 Total materials required = (2000 × 36/6) + (1500 × 24/6) + (4000 × 15/6) = 28 000 kg
Answer = B

11.15 The 400 labour hours unused capacity has zero relevant cost. The remaining 100 hours can be obtained from diverting production from product X. The relevant cost of this alternative consists of the labour cost (100 hours × £12) plus the lost contribution from the use of these labour hours (100/2 × £4 = £200), giving a total of £1400 (see 'Determining the relevant costs of direct labour' in Chapter 11 for an explanation of this point). In other words, the relevant cost is the lost contribution before deducting unavoidable labour costs. The other alternative is to work overtime resulting in an additional (relevant) cost of £1800 (100 hours at £18 per hour). Therefore it is cheaper to divert labour hours from the production of product X.
Therefore answer = C

11.16 The relevant cost consists of the additional acquisition and installation costs less realizable value. Therefore the relevant cost is £150 000 + £25 000 – £10 000 = £165 000.
Answer = C

11.17 The material is in regular use and if used will have to be replaced at a cost of £1950 (600 × £3.25). The cash flow consequences are £1950.
Answer = D

11.18 Assuming that fixed costs will remain unchanged whether or not the company makes or buys the components the relevant cost of manufacture will be the variable cost. Under these circumstances the company should only purchase components if the purchase price is less than the variable cost. Therefore the company should only purchase component T.
Answer = D

11.19 Incremental cost of new employees = £40 000 × 4 = £160 000
Supervision is not an incremental cost.
Incremental costs of retraining
= £15 000 + £100 000 replacement cost = £115 000
Retraining is the cheaper alternative and therefore the relevant cost of the contract is £115 000.
Answer = B

11.20 Answer = B (All of the remaining items are not relevant costs)

11.21 The material is readably available and the use of the materials will necessitate their replacement. The relevant cost is therefore the replacement cost of £4050 (1250 kg at £3.24).
Answer = B

11.22 Specific (avoidable) fixed overheads per division = £262.5 × 60% = £157.5/3 = £52.5
The specific fixed costs are deducted from the divisional contributions to derive the following contributions (£000's) to general fixed costs:
Division A = £17.5
Division B = £157.5
Division C = –£22.5
Only divisions A and B should remain open since they both provide positive contributions to general fixed costs.
Answer = B

11.23 The relevant costs are as follows:

	£	
Material V	900	(1)
Material I	6 500	(2)
Material C	2 050	(3)
Department 1	—	(4)
Department 2	26 000	(5)
Overheads	—	(6)
Minimum price	35 450	

Notes:
1. The original purchase price is a sunk cost. The impact of using the materials on the contract will be the lost cash flows of £900 (300kg × £3) from the sale of the materials.
2. The original purchase price is a sunk cost. Because the materials are in continuous use their usage will result in their replacement at £6.50 per litre.
3. The alternative use of the 300kg in stock would be to use them as a substitute for material Y thus saving purchase costs of £1050 (300/2 × £7). Therefore the impact of using these materials on the contract results in additional costs associated with material Y of £1050. In addition, 250kg of materials C will be purchased for £1000 (250kg at £4 per kg) giving a total relevant cost of £2050.
4. Because there is spare capacity no additional labour costs will be incurred in undertaking the contract.
5. To obtain the labour for this contract the company has a choice of two alternatives. First, work overtime at an additional labour cost to the company of £30 000 (2000 hours × 1.5 × £10). Second labour can be diverted from other production at a lost contribution of £26 000 (2000 hours × (labour cost + lost contribution). In other words, the relevant cost is the lost contribution before deducting unavoidable labour costs (see 'Determining the relevant costs of direct labour' in Chapter 11 for an explanation of this point). It is cheaper to divert labour from other production. Therefore relevant cost = £26 000.
6. There are no additional overheads incurred in undertaking the contract so the relevant cost is zero.

11.24 (a)

	V (£)	W (£)	X (£)	Y (£)	Z (£)
Selling price	16	15	18	15	30
Material	3	3	4	3	6
Skilled labour	6	6	9	3	12
Unskilled labour	2.4	2.4	1.2	1.2	4.8
Variable overhead	2	2	2	1	4
Total variable cost	13.4	15.4	16.2	12.2	26.8
Contribution	2.6	(0.4)	1.8	2.8	3.2
Number of skilled hours	1	1	1.5	0.5	2
Contribution per skilled hour	2.6	(0.4)	1.2	5.6	1.6
Ranking	2	Drop	4	1	3
Skilled hours allocated (W1)	3000		5500 (Balance)	3500	18 000

The product mix will be:

	(£)
Y (7000 units × £2.80 contribution)	19 600
V (3000 units × £2.60 contribution)	7 800
Z (9000 units × £3.20 contribution)	28 800
X (5500 hours × £1.80 contribution)	6 600
1.5 hours	
Total contribution	62 800
Less fixed costs	22 800
Maximum profit	40 000

Workings:
(W1) Maximum units demanded X skilled hours per unit.

(b) If the labour hours constraint is removed the output of product X should be increased to the maximum demand of 6000 units. At present the constraint on skilled labour hours results in a lost contribution of £4201 (6000 units less 3666 units allocated in (a) × £1.80 unit contribution). Therefore the company should consider ways of removing this constraint. As long as the costs of removing the constraint are less than £4201, total profit will increase. Product W should be dropped from the range provided it does not affect the sales of other products.

11.25 (a)

	Relevant costs of the project
Material A	(1 750)
Material B	8 000
Direct labour	7 000
Net cost of machinery	4 750
Relevant cost	18 000
Contract price	30 000
Contribution	12 000

Notes:
(1) There is a saving in material costs of £1750 if material A is not used.
(2) The actual cost of material B represents the incremental cost.
(3) The hiring of the labour on the other contract represents the additional cash flows of undertaking this contract.
(4) The net cost of purchasing the machinery represents the additional cash flows associated with the contract.

(5) Supervision and overheads will still continue even if the contract is not accepted and are therefore irrelevant.

(b) The report should indicate that the costs given in the question do not represent incremental cash flows arising from undertaking the contract. As the company is operating at an activity level in excess of break-even point any sales revenue in excess of £18 000 incremental costs will provide an additional contribution which will result in an increase in profits. Assuming that the company has spare capacity, and that a competitor is prepared to accept the order at £30 000, then a tender price slightly below £30 000 would be appropriate.

(c) Before accepting the contract the following non-monetary factors should be considered.

(i) Is there sufficient spare capacity to undertake the project?

(ii) Is the overseas customer credit worthy?

(iii) Has the workforce the necessary skills to undertake the project?

(iv) Is the contract likely to result in repeat business with the customer?

(d) If the company were operating below the break-even point, acceptance of the order would provide a further contribution towards fixed costs and reduce the existing loss. In the short term it is better to accept the order and reduce the total loss but if, in the long run, there are not enough orders to generate sufficient contributions to cover total fixed costs, then the company will not survive.

11.26 (a)

	North East (£)	South coast (£)
Material X from stock (i)	19 440	
Material Y from stock (ii)		49 600
Firm orders of material X (iii)	27 360	
Material X not yet ordered (iv)	60 000	
Material Z not yet ordered (v)		71 200
Labour (vi)	86 000	110 000
Site management (vii)	—	—
Staff accommodation and travel for site management (viii)	6 800	5 600
Plant rental received (ix)	(6000)	—
Penalty clause (x)		28 000
	193 600	264 400
Contract price	288 000	352 000
Net benefit	94 400	87 600

(b) (i) If material X is not used on the North East contract the most beneficial use is to use it as a substitute material thus avoiding future purchases of £19 440 (0.9 × 21 600). Therefore by using the stock quantity of material X the company will have to spend £19 440 on the other materials.

(ii) Material Y is in common use and the company should not dispose of it. Using the materials on the South coast contract will mean that they will have to be replaced at a cost of £49 600 (£24 800 × 2). Therefore the future cash flow impact of taking on the contract is £49 600.

(iii) It is assumed that with firm orders for materials it is not possible to cancel the purchase. Therefore the cost will occur whatever future alternative is selected. The materials will be used as a substitute material if they are not used on the contract and therefore, based on the same reasoning as note (i) above, the relevant cost is the purchase price of the substitute material (0.9 × £30 400).

(iv) The material has not been ordered and the cost will only be incurred if the contract is undertaken. Therefore additional cash flows of £60 000 will be incurred if the company takes on the North East contract.

(v) The same principles apply here as were explained in note (iv) and additional cash flows of £71 200 will be incurred only if the company takes on the South coast contract.

(vi) It is assumed that labour is an incremental cost and therefore relevant.

(vii) The site management function is performed by staff at central headquarters. It is assumed that the total company costs in respect of site management will remain unchanged in the short term whatever contracts are taken on. Site management costs are therefore irrelevant.

(viii) The costs would be undertaken only if the contracts are undertaken. Therefore they are relevant costs.

(ix) If the North East contract is undertaken the company will be able to hire out surplus plant and obtain a £6000 cash inflow.

(x) If the South coast contract is undertaken the company will have to withdraw from the North East contract and incur a penalty cost of £28 000.

(xi) The headquarter costs will continue whichever alternative is selected and they are not relevant costs.

(xii) It is assumed that there will be no differential cash flows relating to notional interest. However, if the interest costs associated with the contract differ then they would be relevant and should be included in the analysis.

(xiii) Depreciation is a sunk cost and irrelevant for decision-making.

11.27 (a) (i)

Product	A (£)	B (£)	C (£)
Selling price	15	12	11
Less variable costs:			
Materials	(5)	(4)	(3)
Labour	(3)	(2)	(1.5)
Variable overhead (1)	(3.50)	(2)	(1.5)
Contribution	3.50	4	5

Note:

(1) Fixed overheads are apportioned to products on the basis of sales volume and the remaining overheads are variable with output.

(ii)

Product	B (£)	C (£)
Selling price	12	9.50
Less variable costs:		
Materials	(4)	(3)
Labour	(2)	(1.80)
Variable overhead	(2)	(1.50)
Contribution	4	3.20

(b) (i)

Product	A	B	C	Total
Total contribution	350 000	480 000	400 000	1 230 000
Less fixed costs:				
Labour				(220 000)
Fixed administration				(900 000)
Profit				110 000

(ii)

Product	B	C	Total
Total contribution[a]	480 000	576 000	1 056 000
Less fixed costs:			
Labour[b]			(160 000)
Fixed administration[c]			(850 000)
Profit			46 000

Notes:
[a]B = 120 000 units × £4 contribution,
C = 180 000 units × £3.20 contribution.
[b](25% × £320 000 for B) plus (25% × £160 000 × 2 for C).
[c]Fixed administration costs will decline by ¼ of the amount apportioned to Product A (¼ of 380 × £900 000). Therefore fixed overheads will decline from £900 000 to £850 000.

(c) Product A should not be eliminated even though a loss is reported for this product. If Product A is eliminated the majority of fixed costs allocated to it will still continue and will be borne by the remaining products. Product A generates a contribution of £350 000 towards fixed costs but the capacity released can be used to obtain an additional contribution from Product C of £176 000 (£576 000 – £400 000). This will result in a net loss in contribution of £174 000. However, fixed cost savings of £110 000 (£50 000 administration apportioned to Product A plus £100 000 labour for A less an extra £40 000 labour for Product C) can be obtained if Product A is abandoned. Therefore there will be a net loss in contribution of £64 000 (£174 000 – £110 000) and profits will decline from £110 000 to £64 000.

11.28 Profits will be increased up to the point where marginal cost equals marginal revenue (see Chapter 2 for a definition of marginal cost and marginal revenue). The following schedule shows the calculation of marginal cost and marginal revenues for different output levels.

Demand Units	Selling Price per unit £	Total Revenue £ (units × unit selling price)	Marginal Revenue £	Cost per unit £ (units × cost per unit)	Total Cost £	Marginal Cost £
1100	48	52 800	52 800	22	24 200	24 200
1200	46	55 200	2 400	21	25 200	1 000
1300	45	58 500	3 300	20	26 000	800
1400	42	58 800	300	19	26 600	600

Marginal cost exceeds marginal revenue at output levels above 1300 units. Therefore profits are maximized at an output level of 1300 units and a selling price of £45 per unit.

Chapter 12

12.6 The feasible output area is BCDA (see Chapter 12 for an explanation). To determine the optimal output level at which profits are maximized the objective function line (i.e. the contribution line OF) is extended to the right by a series of parallel lines. These lines take on higher total contribution levels as they are moved to the right. The aim is to determine the highest contribution attainable within the feasible region. This will occur at point D.

12.7 The feasible output area is the area to the left where constraints (1) and (3) intersect. To determine the optimal output level at which profits are maximized the objective function dotted line is extended to the right by a series of parallel lines. These lines take on higher total contribution levels as they are moved to the right. The aim is to determine the highest contribution attainable within the feasible region. This will occur at the point where constraint 1 intersects with the x-axis.
Answer = D

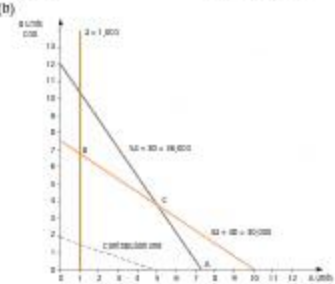
12.8 Where the objective function is to minimize total costs the potential optimal solutions will be at the points closest to the origin that fall within the feasible region. Therefore the optimal solution will be at either points E or D. Note that total costs are lower for E compared with A since E and A entail the same output of U units but E has a lower output of A units.
Answer = C

12.9 (a) Objective is to maximize profit:

Let a = the number of units of A to be produced
Let b = the number of units of B to be produced

Objective function:	9a + 23b
Constraints:	
Non-negativity	b ≥ 0
Minimum requirement of A	a ≥ 1,000
Materials	3a + 4b ≤ 30,000
Labour	5a + 3b ≤ 36,000

(b)



The feasible output region is ABC. To determine the contribution line, a random total contribution is selected. It is easier to establish a random

contribution if it is based on a common denominator for the objective function 9a + 23b. If a random contribution of £41 400 is selected this could be obtained by producing 4600 units of A (£41 400/£9) or 1800 units of B (£41 400/£23). The objective function line for a total contribution of £41 400 is therefore drawn from 4600 units of A and 1800 units of B. This is represented by the dashed line in the diagram. To determine the optimal output level at which profits are maximized, the objective function dashed line is extended to the right by a series of parallel lines. These lines take on higher total contribution levels as they are moved to the right. The aim is to determine the highest contribution attainable within the feasible region. This will occur at the point B. At this point the equations a = 1000 and 3a + 4b = 30 000 are the binding constraints. Given that a = 1000 we can determine the value for b in the second equation:

$$3(1000) + 4b = 30\,000$$

so that, b = 6750.

Therefore the optimal production plan is to produce 1000 units of A and 6750 units of B.

12.10 (a) Let M = number of units of Masso produced and sold.
Let R = number of units of Russo produced and sold.
The linear programming model is as follows:

Maximize $Z = 40M + 50R$ (production contributions)

subject to

$M + 2R$	≤ 700	(machining capacity)
$2.5M + 2R$	≤ 1000	(assembly capacity)
M	≤ 400	(maximum output of Masso constraint)
R	≤ 400	(maximum output of Russo constraint)
M	≥ 0	
R	≥ 0	

The constraints are plotted on the graph as follows:
Machining constraint: line from ($M = 700$, $R = 0$) to ($R = 350$, $M = 0$)
Assembly constraint: line from ($M = 400$, $R = 0$) to ($R = 500$, $M = 0$)
Output of Masso constraint: line from $M = 400$
Output of Russo constraint: line from $R = 400$

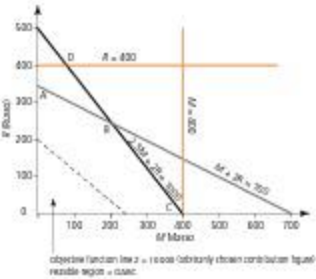
At the optimum point (B in the graph) the output mix is as follows:

	(£)
200 units of Masso at a contribution of £40 per unit =	8 000
250 units of Russo at a contribution of £50 per unit =	12 500
Total contribution	20 500
Less fixed costs (£7000 + £10 000)	17 000
Profit	3 500

The optimum output can be determined exactly by solving the simultaneous equations for the constraints that intersect at point B:

$$2.5M + 2R = 1000 \quad (1)$$

$$M + 2R = 700 \quad (2)$$



objective function line z = (arbitrarily chosen contribution figure)
feasible region = OABC

Subtract equation (2) from equation (1):

$$1.5M = 300$$

$$M = 200$$

Substituting in equation (1):

$$2.5 \times 200 + 2R = 1000$$

$$R = 250$$

(b) *Machining capacity*
If we obtain additional machine hours, the line $M + 2R = 700$ will shift upward. Therefore the revised optimum point will fall on the line BD. If one extra machine hour is obtained, the constraints $M + 2R = 700$ and $2.5M + 2R$ will still be binding and the new optimal plan can be determined by solving the following equations:

$$M + 2R = 701 \text{ (revised machining constraint)}$$

$$2.5M + 2R = 1000 \text{ (unchanged assembly constraint)}$$

The values for M and R when the above equations are solved are $M = 199.33$ and $R = 250.83$.

Therefore Russo is increased by 0.83 units and Masso is reduced by 0.67 units and the change in contribution will be as follows:

		(£)
Increase in contribution from Russo (0.83 × £50)	=	41.50
Decrease in contribution from Masso (0.67 × 40)	=	(26.80)
Increase in contribution		14.70

Hence the value of an independent marginal increase in machine capacity is £14.70 per hour.

Assembly capacity
With an additional hour of assembly capacity, the new optimal plan will be given by the solution of the following equations:

$$M + 2R = 700 \text{ (unchanged machining constraint)}$$

$$2.5M + 2R = 1001 \text{ (revised assembly constraint)}$$

The values for M and R when the above equations are solved are $M = 200.67$ and $R = 249.67$. Therefore Masso is increased by 0.67 units and Russo is decreased by 0.33 units, and the change in contribution will be as follows:

		(£)
Increase in contribution from Masso (0.67 × £40)	=	26.80
Decrease in contribution from Russo (0.33 × £50)	=	(16.50)
Increase in contribution		10.30

Hence the value of an independent marginal increase in assembly capacity is £10.30 per hour.

(c) The assumptions underlying the above calculations are:
(i) linearity over the whole output range for costs, revenues and quantity of resources used;
(ii) divisibility of products (it is assumed that products can be produced in fractions of units);
(iii) divisibility of resources (supplies of resources may only be available in specified multiples);
(iv) the objectives of the firm (it is assumed that the single objective of a firm is to maximize short-term contribution);
(v) all of the available opportunities for the use of the resources have been included in the linear programming model.

Chapter 13

13.16

	W (£000)	X (£000)	Y (£000)
Gross margin	1100	1750	1200
Less customer related costs:			
Sales visits at £500 per visit	55	50	85
Order processing at £100 per order placed	100	100	150
Despatch costs at £100 per order placed	100	100	150
Billing and collections at £175 per invoice raised	157	210	262
Profit/(loss)	688	1290	553
Ranking	2	1	3

Answer = C

13.17 Budgeted number of batches per product:

D = 1000 (100 000/100)
R = 2000 (100 000/50)
P = 2000 (50 000/25)
5000

Budgeted machine set-ups:

D = 3 000 (1000 × 3)
R = 8 000 (2000 × 4)
P = 12 000 (2000 × 6)
23 000

Budgeted cost per set-up = £150 000/23 000 = £6.52
Budgeted set-up cost per unit of R = (£6.52 × 4)/50 = £0.52
Answer = A

13.18 (a) (i) Service (or support) centres (see Chapter 4) exist to provide services of various kinds to other units within the organization. They provide essential services to support the production process, but they do not deal directly with the products produced. Examples include stores and maintenance departments.

(ii) A production centre is a centre where units of output are actually made. Examples include machining and assembly centres.

Overheads are assigned to service centres and the total costs of the service centres are allocated to production centres resulting in all overheads being assigned only to production centres. Overhead rates are established for each production centre and service centre costs are assigned to production within the production centre overhead rates.

(b) See 'A comparison of traditional and ABC systems' and 'Volume-based and non-volume-based cost drivers' in Chapter 13 for the answer to this question.

13.19 The answer to the question should describe the two-stage overhead allocation process and indicate that most cost systems use direct labour hours in the second stage. In today's production environment direct labour costs have fallen to about 10% of total costs for many firms and it is argued that direct labour is no longer a suitable base for assigning overheads to products. Using direct labour encourages managers to focus on reducing direct labour costs when they represent only a small percentage of total costs.

Approaches which are being adopted include:

(i) Changing from a direct labour overhead-recovery rate to recovery methods based on machine time. The justification for this is that overheads are caused by machine time rather than direct labour hours and cost.
(ii) Implementing activity-based costing systems that use many different cost drivers in the second stage of the two-stage overhead allocation procedure.

The answer should then go on to describe the benefits of ABC outlined in Chapter 13. Attention should also be drawn to the widespread use of direct labour hours by Japanese companies. According to Hiromoto[1] Japanese companies allocate overhead costs using the direct labour cost/hours to focus design engineers' attention on identifying opportunities to reduce the products' labour content. They use direct labour to encourage designers to make greater use of technology because this frequently improves long-term competitiveness by increasing quality, speed and flexibility of manufacturing.

Notes

[1]Hiromoto, T. (1988) 'Another hidden edge – Japanese management accounting', *Harvard Business Review*, July/August, pp. 22–6.

13.20 (a) Total machine hours = (120 × 4 hrs) + (100 × 3 hrs) + (80 × 2 hrs) + (120 × 3 hrs) = 1300 hrs

Machine hour overhead rate = $\frac{£30\,430 + £5250 + £3600 + £2100 + £4620}{1300 \text{ hrs}}$ = £20 per machine hour

Product	A (£)	B (£)	C (£)	D (£)
Direct material	48	50	30	60
Direct labour	28	21	14	21
Overheads at £20 per machine hour	88	60	40	60
	164	131	84	141
Units of output	120	100	80	120
Total cost	£17 760	£13 100	£6720	£16 920

(b)

Costs	(£)	Cost driver	Cost driver transactions	Cost per unit (£)
Machine department	10 430	Machine hours	1300 hours	8.02
Set-up costs	5 250	Production runs	21	250
Stores receiving	3 600	Requisitions raised	80 (4 × 20)	45
Inspection/quality control	2 100	Production runs	21	100
Materials handling	4 620	Number of orders executed	42	110

Note
Number of production runs = Total output (420 units)/20 units per set-up.
Number of orders executed = Total output (420 units)/10 units per order.
The total costs for each product are computed by multiplying the cost driver rate per unit by the quantity of the cost driver consumed by each product.

	A	B	C	D
Prime costs	8 160 (£68 × 120)	7 100	2520	9 720
Set ups	1 500 (£250 × 6)	1 250 (£250 × 5)	1000	1 500
Stores/receiving	900 (£45 × 20)	900	900	900
Inspection/quality	600 (£100 × 6)	500	400	600
Handling despatch	1 320 (£110 × 12)	1 100 (£110 × 10)	880	1 320
Machine dept cost*	3 851	2 407	1284	2 808
Total costs	16 331	13 257	7084	16 928

Note
*A = 120 units × 4 hrs × £8.02; B = 100 units × 3 hrs × £8.02

(c) Cost per unit

Costs from (a)	148.00	131.00	84.00	141.00
Costs from (b)	136.09	132.57	99.80	141.07
Difference	(11.91)	1.57	15.80	0.07

Product A is over-costed with the traditional system. Products B and C are under-costed and similar costs are reported with Product D. It is claimed that ABC more accurately measures resources consumed by products. Where cost-plus pricing is used, the transfer to an ABC system will result in different product prices. If activity-based costs are used for stock valuations then stock valuations and reported profits will differ.

Chapter 14

14.7 The calculation of accurate expected values are dependent on the accuracy of the probability distribution. It also takes no account of risk.
Therefore the answer is D.

14.8 Expected income with advertising = (£200 000 × 0.95) + (£70 000 × 0.05) = £193 500
Expected income without advertising = (£200 000 × 0.7) + (£70 000 × 0.3) = £161 000
The maximum amount the company should pay for advertising is the increase in expected value of £32 500.
Therefore the answer is A.

14.9 Answer = A

14.10 Expected value of new building = (0.8 × £2 million) + (0.2 × £1 million) – £1 million
= £0.8 million
Expected value of upgrade = (0.7 × £2 million) + (0.3 × £1 million) – upgrade (?)
= £1.7 million – upgrade
Cost of upgrade to make the company financially indifferent = £0.9 million (1.7 – 0.8 million)
Answer = B

14.11 (a)

Expected cash flows	Ranking
L = (£500 × 0.2) + (£470 × 0.5) + (£550 × 0.3) = £500	2
M = (£400 × 0.2) + (£550 × 0.5) + (£570 × 0.3) = £526	1
N = (£450 × 0.2) + (£400 × 0.5) + (£475 × 0.3) = £432.5	4
O = (£360 × 0.2) + (£400 × 0.5) + (£420 × 0.3) = £398	5
P = (£600 × 0.2) + (£500 × 0.5) + (£425 × 0.3) = £497.5	3

Answer = B

(b) Without additional information machine M (see part a) will be purchased. If perfect information is obtained the choice will be matched with the level of demand. Therefore if the market condition is predicted to be poor P will be chosen and if the market condition is predicted to be good or excellent M will be chosen. The expected values of these outcomes is:
(£600 × 0.2 for P) + (£550 × 0.5 for M) + (£570 × 0.3 for M) = £566
This represents an increase in £40 000 expected value (£566 – £526)
Answer = D

14.12 The decision tree is shown in Figure 14.12. The company is faced with choosing between three alternatives at the decision point (represented by the box labelled 1 in the diagram). The circles represent the possible outcomes that can occur and the probabilities of these outcomes are shown on the lines emanating from the circles. Note that for the first alternative (undertaking the survey) the probabilities for the two branches in the top right hand corner of the diagram are derived from the joint probabilities of two events occurring (i.e. the multiplication of the probability of one event occurring by the probability of the other event occurring).
Therefore the probabilities are 0.76 (0.95 × 0.8), 0.004 (0.8 × 0.05) and 0.2 (1 × 0.2).

The highest expected value is £840 000 for the third alternative (build the small premises without any survey) and, based on the expected value decision rule, this alternative should be chosen.

FIGURE 14.12 *Decision tree*



Chapter 15

15.11 Using the interpolation method the IRR is:

$$15\% + \frac{£3664}{(£3664 + £21\,451)} \times (20\% - 15\%) = 15.7\%$$

Answer = A

15.12 Because the same amount is paid each period the cumulative (annuity) discount tables in Appendix B can be used. For 12 periods at 3% the annuity factor is 9.954. The present value 3 months from now will be £2986 (300 × 9.954). Assuming that the first payment is made at the beginning of month 3 this is the equivalent to the end of month 2 for discounting purposes. Therefore it is necessary to discount the present value back two months (periods) to today (time zero). Using the discount factor from Appendix A for 3% and 2 periods the present value at time zero is £2816 (£2986 × 0.9426). Therefore the answer is A.

15.13 Answer = B

15.14

Time	Cash flow (£000)	Discount factor at 8%	Present value (£000)
0	(20 000)	1.0	(20 000)
1–4	3 000	3.312	9 936
5–8	7 000	2.435 (5.747 –3.312)	17 045
10	(10 000)	0.463	(4 630)
		NPV	2 351

Note that the discount factors for periods 1–4 and 5–8 are derived from the annuity tables since the cash flows are constant per period for the time period involved.
Answer = D

15.15 Applying formula 15.5 shown in Chapter 15:

$$IRR = 10\% + \left(\frac{383}{383 - (-246)}\right)(15\% - 10\%)$$

$$IRR = 10\% + \left(\frac{383}{383 + 246}\right) \times 5\%$$

$$IRR = 10\% + \left(\frac{383}{629}\right) \times 5\%$$

$$IRR = 10\% + 3\% = 13\%$$

Answer = B

15.16 Answer = A (Note that if the cash inflows exceeded the outflows the line from the y axis would start from above zero).

15.17 The present value of a perpetuity can be calculated using the formula:
Cash flow per period/the interest rate
The above formula is based on the assumption that the first cash flow is received in one period's time but the question states that the first cash flow is received immediately.
Let CF represent the annual cash flow

CF + CF/0.08 = £5000
0.08CF + CF = £5 000 × 0.08
1.08CF = £400
CF = £400/1.08 = £370.37
Answer = A

15.18 The annual percentage rate (APR) IS 12.68%, which is based on annual payments.
Monthly interest rate = $\sqrt[12]{1.1268} - 1 = 0.01$ so that $r = 1\%$
In other words a monthly interest rate compounded for 12 periods at 1% is equivalent to an annual rate of 12.68%. This is derived from using the compound interest formula used in the chapter = $(1 + 0.01)^{12} - 1 = 0.1268 = 12.68\%$
To determine the future value of an annuity where a constant amount is invested each period the future value $= A\left[\frac{(1+r)^n - 1}{r}\right]$ where r is the rate of interest per period and A is the annuity amount.

$$\text{Future value} = 50 \times \left[\frac{1.01^{12\times12} - 1}{.01}\right] = £18610$$

Answer = D

15.19 Because the investment is a constant amount each period we can use the annuity future value formula shown in the answer to question 15.18.

$$\text{Future value} = £5 \times \left[\frac{1.005^{12\times5} - 1}{.005}\right] = £348.85$$

Answer = C

15.20 Because the investment is a constant amount each period we can use the annuity future value formula shown in the answer to question 15.18:

Future value $= A\left[\frac{(1+r)^n - 1}{r}\right]$ where r is the rate of interest per period and A is the annuity amount.

$$£7000 = A \times \left[\frac{1.005^{12\times3} - 1}{.005}\right]$$

£7000 = 69.77A
A = £100.33
Answer = C

15.21 The loan represents the present value of a series of repayments over a three year period. Since the payments are constant per period we can use the following annuity present value formula:

$$\text{Present value} = \frac{A}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

where A is the annuity amount and r is the interest rate per period.
The annual interest rate must be converted to a monthly rate since we are dealing with monthly repayments.
Monthly interest rate = $\sqrt[12]{1.10} - 1 = .0079$ (i.e. 0.79%)

$$\text{Present value (2000)} = \frac{A}{0.0079}\left[1 - \frac{1}{1.0079^{36}}\right]$$

$$2000 = \frac{A}{0.0079}(0.2467)$$

$2000\,(0.0079) = 0.2467A$
$A = 15.8/.2467 = £64.04$
Answer = B

15.22 Investment 1

Time	Cash Flows £000	Discount factor at 10%	Present Value £000
0	(75)	1	(75)
1–4	25	3.17	79.25
5	5	0.621	3.105
			7.355

Investment 2

Time	Cash Flows £000	Discount factor at 10%	Present Value £000
0	(100)	1	(100)
1–∞	11	1/0.1 = 10	110
			10

Investment 3

Time	Cash Flows £000	Discount factor at 10%	Present Value £000
0	(125)	1	(125)
1	30	0.909	27.27
2	40	0.826	33.04
3	50	0.751	37.55
4	60	0.683	40.98
5	(10)	0.621	(6.21)
			7.63

Since investment 2 has the highest net present value it would be the preferred investment.

15.23 (a) Applying the formula shown in question 15.18:

$$\text{Future value} = 50 \times \left[\frac{1.01^{18\frac{1}{12}} - 1}{0.01}\right] = £11501.94$$

We must now compound forward a further 5 years at an annual rate of 15%:
$£11\,501.95 \times (1.15)^5 = £23\,134.53$

(b) (i)

Loan 1
APR of 9.38% results in a monthly rate of $\sqrt[12]{1.0938} = 1.0075$ so that $r = .0075$ (i.e. .75%)
The loan represents the present value of a series of repayments over a three year period. Since the payments are constant per period we can use the following annuity present value formula:

$$\text{Present value} = \frac{A}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

where A is the annuity amount and r is the interest rate per period.

$$\text{Present value } (2000) = \frac{A}{0.0075}\left[1 - \frac{1}{1.0075^{36}}\right]$$

$$2000 = \frac{A}{0.0075}(0.23585)$$

$2000\,(0.0075) = 0.23585A$
$A = 15/.23585 = £63.60$

Loan 2
APR of 12.68% results in a monthly rate of $\sqrt[12]{1.1268} = 1.01$ so that $r = .01$ (i.e. 1%)

$$\text{Present value } (2000) = \frac{A}{0.01}\left[1 - \frac{1}{1.01^{24}}\right]$$

$$2000 = \frac{A}{.01}(0.2124)$$

$2000\,(.01) = 0.2124A$
$A = 20/.2124 = £94.16$

(ii)
Loan 1 total amount repaid = £63.60 × 36 = £2289.60
Loan 2 total amount repaid = £94.16 × 24 = £2259.84
Loan 2 is the slightly cheaper loan

15.24 (a) (i) Average capital invested

$$= \frac{£50\,000 + £10\,000}{2} = £30\,000$$

For an explanation of why the project's scrap value is added to the initial cost to calculate the average capital employed, you should refer to note 1 at the end of Chapter 15.

Note that the mid-point of the project's life is two years and the written down value at the end of year 2 is £30 000.

Average annual profit (Project A)

$$= \frac{£25\,000 + £20\,000 + £15\,000 + £10\,000}{4}$$

$= £17\,500$

Average annual profit (Project B)

$$= \frac{£10\,000 + £10\,000 + £14\,000 + £26\,000}{4}$$

$= £15\,000$

Average annual return:

A $\left(\frac{£17\,500}{£30\,000} \times 100\right)$ 58.33%

B $\left(\frac{£15\,000}{£30\,000} \times 100\right)$ 50%

(ii) Payback period:

Project A $\left(1 + \frac{£15\,000}{£30\,000}\right)$ 1.5 years

Project B $\left(2 + \frac{£10\,000}{£24\,000}\right)$ 2.4 years

(iii)

Year	Project A Cash inflows (W1) (£)	Project B Cash inflows (W1) (£)	Discount factor	Project A PV (£)	Project B PV (£)
1	35 000	20 000	0.909	31 815	18 180
2	30 000	20 000	0.826	24 780	16 520
3	25 000	24 000	0.751	18 775	18 024
4	20 000	36 000	0.683	13 660	24 588
4	10 000	10 000	0.683	6 830	6 830
				95 860	84 142
		Investment cost		(50 000)	(50 000)
			NPV	45 860	34 142

Workings:
(W1) Cash flows = Profit + depreciation.
Note that the estimated resale value is included as a year 4 cash inflow.

(b) See Chapter 15 for the answer to this section of the problem.

(c) Project A is recommended because it has the highest NPV and also the shortest payback period.

15.25 (a) The IRR is where:

annual cash inflows × discount factor = investment cost

i.e. £4000 × discount factor = £14 000

Therefore discount factor = £14 000 / £4 000

= 3.5

We now work along the five-row table of the cumulative discount tables to find the discount rate with a discount factor closed to 3.5. This is 13%. Therefore the IRR is 13%.

(b) The annual saving necessary to achieve a 12% internal rate of return is where:

annual savings × 12% discount factor = investment cost

i.e. annual savings × 3.605 = £14 000

Therefore annual savings = £14 000 / 3.605

= £3 883

(c) NPV is calculated as follows:

	(£)
£4000 received annually from years 1–5:	
£4000 × 3.791 discount factor	15 164
Less investment cost	14 000
NPV	1 164

15.26 (a) Project A = $3 \text{ years} + \frac{350 - 314}{112} = 3.32 \text{ years}$

Project B = 3.0 years

Project C = 2.00 years

(b) Accounting rate of return = average profit/average investment

Project A = 79/175 = 45%

Project B = 84/175 = 48%

Project C = 70/175 = 40%

Note that average profit = (sum of cash flows – investment cost)/project's life.

(c) The report should include:

(i) NPVs of each project (project A = £83 200 (W1), project B = £64 000 (W2), project C = £79 000 (W3). A simple description of NPV should also be provided. For example, the NPV is the amount over and above the cost of the project which could be borrowed, secure in the knowledge that the cash flows from the project will repay the loan.

(ii) The following rankings are based on the different evaluation procedures:

Project	IRR	Payback	ARR	NPV
A	2	3	2	1
B	3	2	1	3
C	1	1	3	2

(iii) A discussion of each of the above evaluation procedures.

(iv) IRR is subject to the following criticisms:

1. Multiple rates of return can occur when a project has unconventional cash flows.
2. It is assumed that the cash flows received from a project are re-invested at the IRR and not the cost of capital.
3. Inability to rank mutually exclusive projects.
4. It cannot deal with different sized projects. For example, it is better to earn a return of 35% on £100 000 than 40% on £10 000.

Note that the above points are explained in detail in Chapter 15.

(v) Payback ignores cash flows outside the payback period, and it also ignores the timing of cash flows within the payback period. For example, the large cash flows for project A are ignored after the payback period. This method may be appropriate for companies experiencing liquidity problems who wish to recover their initial investment quickly.

(vi) Accounting rate of return ignores the timing of cash flows, but it is considered an important measure by those who believe reported profits have a significant impact on share prices.

(vii) NPV is generally believed to be the theoretically correct evaluation procedure. A positive NPV from an investment is supposed to indicate the increase in the market value of the shareholders' funds, but this claim depends upon the belief that the share price is the discounted present value of the future dividend stream. If the market uses some other method of valuing shares then a positive NPV may not represent the increase in market value of shareholders' funds. Note that the cash flows have been discounted at the company's cost of capital. It is only suitable to use the company's cost of capital as the discount rate if projects A, B and C are equivalent to the average risk of all the company's existing projects. If they are not of average risk then project risk-adjusted discount rates should be used.

(viii) The projects have unequal lives. It is assumed that the equipment will not be replaced.

(ix) It is recommended that NPV method is used and project A should be selected.

(d) Stadler prefers project C because it produces the highest accounting profit in year 3. Stadler is assuming that share prices are influenced by short-run reported profits. This is in contrast with theory, which assumes that the share price is the discounted present value of the future dividend stream. Stadler is also assuming that the market only has access to reported historical profits and is not aware of the future benefits arising from the projects. The stock market also obtains company information on future prospects from sources other than reported profits. For example, press releases, chairman's report and signals of future prosperity via increased dividend payments.

Workings

(W1) Project A = (100 × 0.8333) + (110 × 0.6944) + (104 × 0.5787) + (112 × 0.4823) + (138 × 0.4019) + (160 × 0.3349) + (180 × 0.2791) – £350

(W2) Project B = (40 × 0.8333) + (100 × 0.6944) + (210 × 0.5787) + (260 × 0.4823) + (160 × 0.4019) – £350

(W3) Project C = (200 × 0.8333) + (150 × 0.6944) + (240 × 0.5787) + (40 × 0.4823) – £350

Chapter 16

16.10 Answer = A

16.11

	(£)	(£)
Cash sales		22 000
Credit sales		
April (70% × 0.6 × 0.98 × £70 000)	28 812	
March (27% × 0.6 × £60 000)	9 720	38 532
		60 532

Answer = C

16.12 Number of units required to meet demand:

	Units
Sales	10 000
Add losing stock	500
Less opening stock	(600)
	9 900

There is a loss of 10% so the production required to meet demand is 11 000 units (9900/0.9)
Answer = D

16.13 Answer = B

16.14 Answer = A

16.15

	Kg
Materials required to meet production requirements (7200 × 3kg)	21 600
Add budgeted closing stock	500
Less opening stock	(400)
Budgeted purchases	21 700

Answer = D

16.16 (a) Cash received = Sales ($160 000) + Opening debtors ($27 500) – Closing debtors ($19 400)
= $168 100
Answer = (iv)

(b) Gross profit = $88 000 (0.55 × $160 000)
Cost of sales = $72 000 ($160 000 – $88 000)
Purchases = Cost of sales ($72 000) + closing stock ($18 700) – opening stock ($16 600)
= $74 100
Answer = (ii)

16.17 (a) *Raw materials:*

(Units)	March	April	May	June
Opening stock	100	110	115	130
Add: Purchases	80	80	85	85
	180	190	200	195
Less: Used in production	70	75	90	90
Closing stock	110	115	110	105
(Units) *Finished production:*				
Opening stock	110	100	90	85
Add: Production	70	75	90	90
	180	175	180	175
Less: Sales	80	84	95	84
Closing stock	100	91	85	91

(b) *Sales:*

					Total
(at £2·9 per unit)	£17 520	£18 396	£21 024	£20 586	£77 526
Production cost:					
Raw materials (using FIFO)	3 024 (1)	3 321 (2)	4 050	4 050	14 445
Wages and variable costs	4 550	4 875	5 850	5 850	21 125
	£7 574	£8 196	£9 900	£9 900	£35 570

Debtors:
Closing debtors = May + June sales = £41 610

Creditors:
June purchases 85 units × £45 £3825

Notes:
(1) 70 units × £4320/100 units = £3024.
(2) (30 units × £4320/100 units) + (45 units × £45) = £3321.

Closing stocks:
Raw materials 105 units × £45 £4725
Finished goods 81 units × £110(*) 8910

Note:
(*)Materials (£45) + Labour and Variable Overhead (£65).
It is assumed that stocks are valued on a variable costing basis.

(c) *Cash budget:*

		March (£)	April (£)	May (£)	June (£)
Balance b/fwd		6 790	4 820	5 545	132 415
Add: Receipts					
Debtors (two months' credit)		7 680	18 480	17 520	18 396
Loan		—	—	120 000	—
	(A)	14 470	23 220	143 065	150 811
Payments:					
Creditors (one month's credit)		3 900	3 600 (80 × £45)	3 600	3 825
Wages and variable overheads		4 550	4 875	5 850	5 850
Fixed overheads		1 200	1 200	1 200	1 200
Machinery		—	—	—	112 000
Interim dividend		—	—	—	12 500
	(B)	9 650	9 675	10 650	135 375
Balance c/fwd	(A) – (B)	4 820	5 545	132 415	415 436

(d) *Master budget:*

Budgeted trading and profit and loss account for the four months to 30 June

	(£)	(£)
Sales		77 536
Cost of sales: Opening stock finished goods	10 450	
Add: Production cost	35 520	
	46 020	
Less: Closing stock finished goods	8 900	37 120
		40 416
Less: Expenses		
Fixed overheads (4 × £1200)	4 800	
Depreciation:		
Machinery and equipment	15 733	
Motor vehicles	3 500	
Loan interest (2/12 × 7½% of £120 000)	1 500	25 533
		14 883
Less: Interim dividends		12 500
		2 383
Add: Profit and loss account balance b/fwd		40 840
		43 223

Budgeted balance sheet as at 30 June

	Cost (£)	Depreciation to date (£)	Net (£)
Fixed assets			
Land and buildings	580 000	—	503 000
Machinery and equipment	236 000	100 233	135 767
Motor vehicles	42 000	19 900	22 100
	778 000	120 133	657 867
Current assets			
Stock of raw materials		4 725	
Stock of finished goods		8 900	
Debtors		41 610	
Cash and bank balances		15 436	
		70 671	
Less: Current liabilities			
Creditors	3 825		
Loan interest owing	1 500	5 325	65 356
			723 223
			(£)
Capital employed			
Ordinary share capital £1 shares (fully paid)			500 000
Share premium			60 000
Profit and loss account			43 223
			603 223
Secured loan (7½%)			120 000
			723 223

(e) See the section of cash budgets in Chapter 16 for possible ways to improve cash management.

16.18 *Task 1*

Alderley Ltd Budget Statements 13 weeks to 4 April

(a) Production Budget

	Elgar units	Holst units
Budgeted sales volume	845	1235
Add closing stock[a]	78	106
Less Opening stock	(163)	(361)
Units of production	760	1148

(b) Material Purchases Budget

	Elgar kg	Holst kg	Total kg
Material consumed	5320 (760 × 7)	9120 (1140 × 8)	14 440
Add raw material closing stock[b]			2 888
Less raw material opening stock			(2 328)
Purchases (kg)			15 000
(c) Purchases (£) (1500 × £12)			£180 000

(d) Production Labour Budget

	Elgar hours	Holst hours	Total hours
Standard hours produced[c]	6080	5700	11 780
Productivity adjustment (5% × 11 780)			620
Total hours employed			12 400
Normal hours employed[d]			11 544
Overtime hours			856

(e) Labour cost

	£
Normal hours (11 544 × £8)	92 352
Overtime (856 × £8 × 125%)	8 560
Total	100 912

Notes:

[a]Number of days per period = 13 weeks × 5 days = 65
Stock: Elgar = (1665) × 845 = 78, Holst = (1465) × 1235 = 266
[b](1385) × (5320 + 9120) = 2888
[c]Elgar 760 × 8 hours = 6080; Holst 1140 × 5 hours = 5700
[d]24 employees × 37 hours × 13 weeks = 11 544

Task 2

(a) Four ways of forecasting future sales volume are:

(i) Where the number of customers is small it is possible to interview them to ascertain what their likely demand will be over the forecasting period.

(ii) Produce estimates based on the opinion of executives and sales personnel. For example, sales personnel may be asked to estimate the sales of each product to their customers, or regional sales managers may estimate the total sales for each of their regions.

(iii) Market research may be necessary where it is intended to develop new products or new markets. This may involve interviews with existing and potential customers in order to estimate potential demand.

(iv) Estimates involving statistical techniques that incorporate general business and market conditions and past growth in sales.

(b) Interviewing customers and basing estimates on the opinions of sales personnel are likely to be more appropriate for existing products and customers involving repeat sales. Market research is appropriate for new products or markets and where the market is large and anticipated revenues are likely to be sufficient to justify the cost of undertaking the research.

Statistical estimates derived from past data are likely to be appropriate where conditions are likely to be stable and past demand patterns are likely to be repeated through time. This method is most suited to existing products or markets where sufficient data is available to establish a trend in demand.

(c) The major limitation of interviewing customers is that they may not be prepared to divulge the information if their future plans are commercially sensitive. There is also no guarantee that the orders will be placed with Alderley Ltd. They may place their orders with competitors.

Where estimates are derived from sales personnel there is a danger that they might produce over-optimistic estimates in order to obtain a favourable performance rating at the budget setting stage. Alternatively, if their future performance is judged by

their ability to achieve the budgeted sales they may be motivated to underestimate sales demand.

Market research is expensive and may produce unreliable estimates if inexperienced researchers are used. Also small samples are often used which may not be indicative of the population and this can result in inaccurate estimates.

Statistical estimates will produce poor demand estimates where insufficient past data is available, demand is unstable over time and the future environment is likely to be significantly different from the past. Statistical estimates are likely to be inappropriate for new products and new markets where past data is unavailable.

16.19 (a) (i) *Cash budget for weeks 1–6*

	Week 1 (£)	Week 2 (£)	Week 3 (£)	Week 4 (£)	Week 5 (£)	Week 6 (£)
Receipts from debtors[1]	24 000	24 000	28 200	25 800	19 800	5 400
Payments:						
To material suppliers[2]	8 000	12 500	6 000	nil	nil	nil
To direct workers[3]	3 200	4 200	2 800	nil	nil	nil
For variable overheads[4]	4 600	5 200	nil	nil	nil	nil
For fixed overheads[5]	6 500	6 500	6 500	6 500	6 500	6 500
Total payments	24 300	28 200	15 300	6 500	6 500	6 500
Net movement	(300)	(4 200)	12 900	19 300	13 300	(1 100)
Opening balance (week 1 given)	1 000	700	(3 500)	9 400	28 700	42 000
Closing balance	700	(3 500)	9 400	28 700	42 000	40 900

Notes

[1]Debtors:

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Units sold[a]	480	500	400	300	—	—
Sales (£)	24 000	30 000	24 000	18 000	—	—
Cash received (70%)		16 800	21 000	16 800	12 600	
(30%)			7 200	9 000	7 200	5 400
Given	24 000	7 200				
Total receipts (£)	24 000	24 000	28 200	25 800	19 800	5 400

[a]Sales in week 4 = opening stock (800 units) + production in weeks 1 and 2 (1000 units) less sales in weeks 1–3 (1300 units) = 300 units.

[2]Creditors:

	Week 1 (£)	Week 2 (£)	Week 3 (£)	Week 4	Week 5	Week 6
Materials consumed at £15	9 000	6 000	—	—	—	—
Increase in stocks	3 500	—				
Materials purchased	12 500	6 000				
Payment to suppliers	8 000 (given)	12 500	6000	nil	nil	nil

[3]Wages:

	Week 1 (£)	Week 2 (£)	Week 3 (£)	Week 4	Week 5	Week 6
Wages consumed at £7	4200	2800	nil	nil	nil	nil
Wages paid	3200 (given)	4200	2800	—	—	—

[4]Variable overhead payment = budgeted production × budgeted cost per unit.

[5]Fixed overhead payments for weeks 1–2 = fixed overhead per week (£6500), less weekly depreciation (£700).

Fixed overhead payments for weeks 3–6 = £6500 normal payment less £1500 per week.

(ii) *Comments*

1. Finance will be required to meet the cash deficit in week 2, but a lowering of the budgeted material stocks at the end of week 1 would reduce the amount of cash to be borrowed at the end of week 2.
2. The surplus cash after the end of week 2 should be invested on a short-term basis.
3. After week 6, there will be no cash receipts, but cash outflows will be £6800 per week. The closing balance of £39 700 at the end of week 6 will be sufficient to finance outflows for a further 5 or 6 weeks (£39 700/£6800 per week).

(b) The answer should include a discussion of the matching concept, emphasizing that revenues and expenses may not be attributed to the period when the associated cash inflows and outflows occur. Also, some items of expense do not affect cash outflow (e.g. depreciation).

Chapter 17

17.19 Answer = A

17.20 Residual income = £120 000 – (18% × £650 000) = £3000
Answer = A

17.21 Divisional managers do not control the cash function. Therefore controllable net assets should exclude the cash overdraft so controllable net assets are £125 000 (£101 000 + £24 000).

Controllable residual income = £69 000 (Profit before interest and tax)

Less cost of capital	=	12 500 (10% × 125 000)
Residual income	=	56 500

Answer = B

17.22 Working backwards to derive the divisional contribution:

	£
Cost of capital charge	150 000 (£1.25m × 12%)
Residual income	47 200
Profit	197 200
Depreciation	247 500
Fixed costs	487 000
Total contribution	931 700

Contribution per unit = £31.06 (£931 700/30 000 units)
Answer = D

17.23 (a)

	Fixed budget		Actual results	Variances
Sales (units)	9 750		8 750	
Production (units)	11 000		11 000	
	£000		£000	£000
Sales revenue	292.5	=(30 × 9750)	325	32.5 favourable
Cost of sales:				
Opening stock	0		0	
Production costs:				
Materials	55	=(5 × 11 000)	65	10 adverse
Labour	99	=(9 × 11 000)	100	1 adverse
Fixed production overheads	96 (1)	=(8 × 12 000)	85	1 favourable
	250		260	10 adverse
Closing stock	27.5	=(£22 × (11 000 – 9750))	27.5	
	222.5		232.5	
Profit	70		92.5	22.5 favourable

(b) The variance will have arisen because the actual selling price was greater than the budgeted price. The adverse materials variance may have resulted either because the number of kg used, or the amount paid per kg, was greater than expected.

17.24 (a) A fixed budget refers to a budget which is designed to remain unchanged irrespective of the level of activity, whereas a flexible budget is a budget which adjusts the expense items for different levels of activity. See 'Flexible budgets' in Chapter 17 for an explanation of the objectives of flexible budgeting.

(b) (i)

Direct labour	£180 000	£202 500	£225 000
Direct labour hours	48 000	54 000	60 000
Flexible budget (overhead expenditure):			
Activity levels	80%	90%	100%
Direct labour hours	48 000	54 000	60 000
Variable costs:	(£)	(£)	(£)
Indirect labour at £0.75 per direct labour hour	36 000	40 500	45 000
Consumable supplies at £0.375 per direct labour hour	18 000	20 250	22 500
Canteen and other welfare services at 8% of direct plus indirect wages	12 960	14 580	16 200
Semi-variable: variable (W1)	9 600	10 800	12 000
	76 560	86 130	95 700
Semi-variable: fixed (W1)	8 000	8 000	8 000
Fixed costs:			
Depreciation	18 000	18 000	18 000
Maintenance	10 000	10 000	10 000
Insurance	4 000	4 000	4 000
Rates	15 000	15 000	15 000
Management salaries	25 000	25 000	25 000
	156 560	166 130	175 700

Workings

(W1) Obtained by using High and Low points method:

			(£)
High	64 000	Direct labour hours	20 800
Low	40 000	Direct labour hours	16 000
	24 000		4 800

£4 800 / 24 000 = £0.20 per direct labour hour

64 000 × £0.20 = £12 800 variable costs

Total costs £20 800
∴ Fixed costs £8 000

(ii) Variable cost

(57 000/60 000 × £95 700)	90 915
Fixed costs	80 000
Budgeted cost allowance	170 915

17.25 (a) (i) Activity varies from month to month, but quarterly budgets are set by dividing total annual expenditure by 4.

(ii) The budget ought to be analysed by shorter intervals (e.g. monthly) and costs estimated in relation to monthly activity.

(iii) For control purposes monthly comparisons and cumulative monthly comparisons of planned and actual expenditure to date should be made.

(iv) The budget holder does not participate in the setting of budgets.

(v) An incremental budget approach is adopted. A zero-based approach would be more appropriate.

(vi) The budget should distinguish between controllable and uncontrollable expenditure.

(b) The information that should flow from a comparison of the actual and budgeted expenditure would consist of the variances for the month and year to date analysed into the following categories:

(i) controllable and uncontrollable items;

(ii) price and quantity variances with price variance analysed by inflationary and non-inflationary effects.

(c) (i) Flexible budgets should be prepared on a monthly basis. Possible measures of activity are number of patient days or expected laundry weight.

(ii) The laundry manager should participate in the budgetary process.

(iii) Costs should be classified into controllable and non-controllable items.

(iv) Variances should be reported and analysed by price and quantity on a monthly and cumulative basis.

(v) Comments should be added explaining possible reasons for the variances.

17.26

Task 1:

Performance Statement – Month to 31 October

Number of guest days = Original budget 9 600
Flexed budget 11 160

	Flexed budget (£)	Actual (£)	Variance (£)
Controllable expenses			
Food (1)	23 436	20 500	2936F
Cleaning materials (2)	2 232	2 232	0
Heat, light and power (3)	2 790	2 050	740F
Catering staff wages (4)	8 370	8 400	30A
	36 828	33 182	3646F
Non-controllable expenses			
Rent, rates, insurance and depreciation (5)	1 860	1 860	0

Notes:

(1) £20 160/9600 × 11 160.
(2) £1920/9600 × 11 160.
(3) £2400/9600 × 11 160.
(4) £11 160/40 × £30.
(5) Original fixed budget based on 30 days but October is a 31-day month (£1860/30 × 31).

Task 2:

(a) See the sections on the multiple functions of budgets (motivation) in Chapter 16, and 'Setting financial performance targets' in Chapter 17 for the answers to this question.

(b) Motivating managers ought to result in improved performance. However, besides motivation, improved performance is also dependent on managerial ability, training, education and the existence of a favourable environment. Therefore motivating managers is not guaranteed to lead to improved performance.

(c) The use of a fixed budget is unlikely to encourage managers to become more efficient where budgeted expenses are variable with activity. In the original performance report actual expenditure for 11 160 guest days is compared with budgeted expenditure for 9600 days. It is misleading to compare actual costs at one level of activity with budgeted costs at another

level of activity. Where the actual level of activity is above the budgeted level adverse variances are likely to be reported for variable cost items. Managers will therefore be motivated to reduce activity so that favourable variances will be reported. Therefore it is not surprising that Susan Green has expressed concern that the performance statement does not reflect a valid reflection of her performance. In contrast, most of Brian Hilton's expenses are fixed and costs will not increase when volume increases. A failure to flex the budget will therefore not distort his performance.

To motivate, challenging budgets should be set and small adverse variances should normally be regarded as a healthy sign and not something to be avoided. If budgets are always achieved with no adverse variances this may indicate that undemanding budgets may have been set which are unlikely to motivate best possible performance. This situation could apply to Brian Hilton who always appears to report favourable variances.

17.27 (a) Return on investment (ROI)

Division A	£
Profit	35 000
Net assets	150 000

Return on investment = 35 000/150 000 = 23.3%

Division B	£
Profit	70 000
Net assets	325 000

Return on investment = 70 000/325 000% = 21.5%

Residual income (RI)
Division A = £35 000 – (150 000 × 0.15) = £12 500
Division B = £70 000 – (325 000 × 0.15) = £21 250
Division A has a higher ROI but a lower residual income.

(b) Return on investment would be the better measure when comparing divisions as it is a relative measure (i.e. based on percentage returns)

(c) Appropriate aspects of performance include:
- competitiveness;
- financial performance;
- quality of service;
- flexibility;
- innovation;
- resource utilization efficiency.

Chapter 18

18.16 A favourable labour efficiency variance indicates that actual hours used were less than the standard hours produced. The favourable variance was £7800. Therefore the standard hours produced were 18 700 (17 500 + £7800/£6.50).
Answer = D

18.17 (a) Material price = (SP – AP)AQ = (AQ × SP) – (AQ × AP)
= (53 000 kg × £2.50) – £136 000 = £3 500A
Answer = (ii)
(b) Material usage = (SQ – AQ)SP = (27 000 × 2 kg = 54 000 kg – 53 000) £2.5 = £2500F
Answer = (i)

18.18 Wage rate = (SP – AP)AH = (AH × SP) – (AH × AP)
= (14 000 × £10 = £140 000) – £176 000 = £36 000A
Labour efficiency = (SH – AH)SP = (5500 × 3 hours = 16 500 hours – 14 000 hours) × £10 = £25 000F
Answer = D

18.19 (a) Standard hours for actual output (650 units × 0.25 hours) = 162.5 hours
Actual hours taken (7 hours × 3 days × 8 employees) – idle time (16 hours) = 152 hours
Efficiency variance (10.5 hours × $12) = $126 Favourable
Answer = (iv)
(b) Wage rate = (SP – AP)AH = (AH × SP) – (AH × AP)
= (168 × $12) – $2275 = $259A
Answer = (ii)

18.20 Standard cost = 31 000 repairs × 24/60 hours × $10.60 = $131 440
Actual cost = $134 540 (standard cost plus adverse labour variance of $3100)
Actual labour hours = 12 400 (31 000 repairs × 0.4 hours) given that actual hours are the same as the standard hours due to a zero labour efficiency variance
Actual wage rate = $10.85 ($134 540/12 400 hours)
Answer = C

18.21 Over-absorbed fixed overheads will result in a favourable total fixed overhead variance. Only item B results in a favourable total fixed overhead variance.
Answer = B

18.22 $\text{Standard fixed overhead rate} = \frac{\text{Budgeted cost (£48 000)}}{\text{Budgeted output (4800 units)}} = £10$

Overheads incurred = Budgeted cost + Expenditure variance (£2000) = £50 000
Overheads absorbed = £50 000 – Under-absorption (£8000) = £42 000
Actual number of units produced = £42 000/£10 = 4200
Answer = C

18.23 Budgeted fixed overhead hour rate = £135 000/9000 = £15
Capacity variance = [Actual hours (9750) – Budgeted hours (9000)] × £15 = £11 250F
Answer = B

18.24 Budgeted sales margin = $66 000 (12 000 units × ($15 – $9.50))
Actual sales margin = $43 200 (10 800 × ($13.50 – $9.50))
Variance = $22 800A
Note that the actual margin is derived from using the standard cost and not the actual cost.
Answer = A

18.25 Variance = (Actual sales volume of 9800 units) – (Budgeted sales volume of 10 000 units) × budgeted profit margin (£5) = £1000 Adverse
Answer = C

18.26 Variance = (Actual sales volume of 3500 units) – (Budgeted sales volume of 3000 units) × budgeted contribution margin (£50 – £31) = £9500 Favourable
Answer = A

18.27 (a) Fixed overhead expenditure variance = Budgeted fixed overheads (£2 500 000) – Actual fixed overheads (£2 890 350) = £390 350 Adverse
Volume variance = (Actual production of 70 000 units) – Budgeted production of 62 500 units) × Budgeted fixed overhead absorption rate per unit (£2 500 000/62 500 units) = £300 000 Favourable
See Chapter 18 for an explanation of each of the variances.
(b) Budgeted fixed overhead absorption rate per hour = £5 (£2 500 000/500 000 hours)
Efficiency variance = (Standard quantity of input hours for actual production) – (Actual input hours) × Fixed overhead absorption rate
= (70 000 units × 500 000 hours/62 500 units = 560 000 hours – 525 000 hours) × £5 = £175 000 Favourable
Capacity variance = (Actual hours of input = 525 000) – (budgeted hours of input = 500 000) × Fixed overhead absorption rate (£5) = £125 000 Favourable
See Chapter 18 for an explanation of each of the variances.

18.28 1. *Preliminary calculations*
The standard product cost and selling price are calculated as follows:

	(£)
Direct materials	
X (10 kg at £1)	10
Y (5 kg at £5)	25
Direct wages (5 hours × £3)	15
Fixed overhead (5 hours × 200% of £3)	30
Standard cost	80
Profit (20/(100 – 20)) × £80	20
Selling price	100

The actual profit for the period is calculated as follows:

	(£)	(£)
Sales (9500 at £110)		1 045 000
Direct materials: X	115 200	
Y	225 600	
Direct wages (46 000 × £3.20)	147 200	
Fixed overhead	290 000	778 000
Actual profit		267 000

It is assumed that the term 'using a fixed budget' refers to the requirement to reconcile the budget with the original fixed budget.

	(£)	(£)
Material price variance:		
(standard price – actual price)		
× actual quantity		
X: (£1 – £1.20) × 96 000	19 200 A	
Y: (£5 – £4.70) × 48 000	14 400 F	4800 A
Material usage variance:		
(standard quantity – actual quantity)		
× standard price		
X: (9500 × 10 = 95 000 – 96 000) × £1	1 000 A	
Y: (9500 × 5 = 47 500 – 48 000) × £5	2 500 A	3500 A

The actual materials used are in standard proportions. Therefore there is no mix variance.

Wage rate variance:		
(standard rate – actual rate) × actual hours		
(£3 – £3.20) × 46 000	9 200 A	
Labour efficiency variance:		
(standard hours – actual hours) × standard rate		
(9500 × 5 = 47 500 – 46 000) × £3	4 500 F	4 700 A
Fixed overhead expenditure:		
budgeted fixed overheads – actual fixed overheads		
(10 000 × £20 = £200 000 – £250 000)		50 000 F
Volume efficiency variance:		
(standard hours – actual hours) × fixed overhead rate (47 500 – 46 000) × £6	9 000 F	
Volume capacity variance:		
(actual hours – budgeted hours) × fixed overhead rate (46 000 – 50 000) × £6	24 000 A	15 000 A
Sales margin price variance:		
(actual margin – standard margin) × actual sales volume (£30 – £20) × 9500	95 000 F	
Sales margin volume variance:		
(actual sales volume – budgeted sales volume) × Standard margin		
(9500 – 10 000) × £20	10 000 A	85 000 F
Total variance		67 000 F

	(£)
Budgeted profit (10 000 units at £20)	200 000
Add favourable variances (see above)	67 000
Actual profit	267 000

18.29 (a) *Standard product cost for one unit of product XY*

	(£)
Direct materials (8 kg (W2) at £1.50 (W1) per kg)	12.00
Direct wages (2 hours (W4) at £4 (W3) per hour)	8.00
Variable overhead (2 hours (W4) at £1 (W5) per hour)	2.00
	22.00

Workings

(W1) Actual quantity of materials purchased at standard price is £225 000 (actual cost plus favourable material price variance).
Therefore standard price = £1.50 (£225 000/150 000 kg).

(W2) Material usage variance = 6000 kg (£9000/£1.50 standard price).
Therefore standard quantity for actual production = 144 000 kg (150 000 – 6000 kg).
Therefore standard quantity per unit = 8 kg (144 000 kg/18 000 units).

(W3) Actual hours worked at standard rate = £128 000 (£136 000 – £8000).
Therefore standard rate per hour = £4 (£128 000/32 000 hours).

(W4) Labour efficiency variance = 4000 hours (£16 000/£4).
Therefore standard hours for actual production = 36 000 hours (32 000 + 4000).
Therefore standard hours per unit = 2 hours (36 000 hours/18 000 units).

(W5) Actual hours worked at the standard variable overhead rate is £32 000 (£38 000 actual variable overheads less £6000 favourable expenditure variance).
Therefore, standard variable overhead rate = £1 (£32 000/32 000 hours).

(b) See 'Types of cost standards' in Chapter 18 for the answer to this question.

18.30 (a) (i) A fixed overhead volume variance only occurs with an absorption costing system. The question indicates that a volume variance has been reported. Therefore the company must operate an absorption costing system and report the sales volume variance in terms of profit margins, rather than contribution margins.

Budgeted profit margin = Budgeted profit (£4250)/Budgeted volume (1500 units)
= £2.83

Adverse sales volume variance in units = £850/£2.83 = 300 units
Therefore actual sales volume was 300 units below budgeted sales volume
Actual sales volume = 1200 units (1500 units – 300 units)

(ii) Standard quantity of material used per units of output:
Budgeted usage (750 kg)/Budgeted production (1500 units) = 0.5 kg
Standard price = Budgeted material cost (£4500)/Budgeted usage (750 kg) = £6
Material usage variance = (Standard quantity – Actual Quantity) Standard price
£150A = (1550 × 0.5 kg = 775 kg – AQ) £6
– £150 = 4650 – 6AQ
6AQ = 4800
Actual quantity used = 800 kg

(iii) Material price variance = (Standard price – Actual price) × Actual purchases
£1000F = (£6 – Actual price) × 1000 kg
£1000F = £6000 – 1000AP
1000AP = £5000
AP = £5 per kg
Actual material cost = 1000 kg × £5 = £5000

(iv) Standard hours per unit of output = Budgeted hours (1125) / Budgeted output (1500 units)
= 0.75 hours

Standard wage rate = Budgeted labour cost (£4500)/Budgeted hours (1125)
= £4

Labour efficiency variance = (Standard hours – Actual hours) × Standard rate
£150A = (1550 × 0.75 = 1162.5 – Actual hours) × £4 – £150 = £4650 – 4AH
4AH = £4800
Actual hours = 1200

(v) Total labour variance = Standard cost – Actual cost
(£200A + £150A) = (1550 × 0.75 hrs × £4) – Actual cost
£350A = £4650 – Actual cost
Actual cost = £5000

(vi) Standard variable overhead cost per unit
= Budgeted variable overheads (2250) / Budgeted output (1500 units)
= £1.50 hours

Total variable overhead variance = Standard cost – Actual cost
(£600A + £75A) = (1550 × £1.50 = £2325) – Actual cost
£675A = £2325 – Actual cost
Actual cost = £3000

(vii) Fixed overhead expenditure variance =
Budgeted cost – Actual cost
£2500F = £4500 – Actual cost
Actual cost = £2000

(b) See Chapter 18 for an explanation of the causes of the direct material usage, direct labour rate and sales volume variances

18.31 (a) Material price:
(standard price – actual price) × actual quantity
(£3 – £4) × 22 000 = £22 000 A

Material usage:
(standard quantity – actual quantity) × standard price ((1400 × 15 = 21 000) – 22 000) × £3 = 3000 A

Wage rate:
(standard rate – actual rate) × actual hours
(£4 – £5) × 6800 = £6800 A

Labour efficiency:
((1400 × 5 = 7000) – 6800) × £4 = £800 F

Fixed overhead expenditure:
(budgeted fixed overheads – actual fixed overheads) (1000 × £5 = £5000 – £6000) = £1000 A

Volume efficiency:
(standard hrs – actual hrs) × FOAR
(1400 × 5 = 7000 – 6800) × £1 = 200 F

Volume capacity:
(actual hrs – budgeted hrs) × FOAR
(6800 – 5000) × £1 = £1800 F

Variable overhead efficiency:
(standard hrs – actual hrs) × VOAR
(7000 – 6800) × £2 = £400 F

Variable overhead expenditure:
(flexed budgeted variable overheads – actual variable overheads) (6800 × £2 – £11 000) = £2600 F

Sales margin price:
(actual margin – standard margin) × actual sales volume
(£102 – £80 = £22 – £20) × 1200 = £2400 F

Sales margin volume:
(actual sales – budgeted sales) × standard margin (1200 – 1000) × £20 = 4000 F

Reconciliation of budgeted and actual profit

			(£)
Budgeted profit			20 000
	Adverse (£)	Favourable (£)	
Sales margin price		2 400	
Sales margin volume		4 000	
Material price	22 000		
Material usage	3 000		
Wage rate	6 800		
Labour efficiency		800	
Fixed overhead expenditure	1 000		
Fixed overhead efficiency		200	
Fixed overhead capacity		1 800	
Variable overhead expenditure		2 600	
Variable overhead efficiency		400	
	32 800	12 200	
Net adverse variance			20 600
Actual profit/(loss)			(600)

(b)

Stores ledger control account

Creditors	66 000	WIP	63 000
		Material usage variance	3 000
	66 000		66 000

Variance accounts

Creditors	22 000	Wages control (labour efficiency)	800
Stores ledger (material usage)	3 000	Fixed overhead (volume)	2 000
Wages control (wage rate)	6 800	Variable overhead (expenditure)	2 600
Fixed overhead (expenditure)	1 000	Variable overhead (efficiency)	400
		Costing P + L a/c (balance)	27 000
	32 800		32 800

Costing P + L account

Cost of sales	96 000	Sales	122 400
Variance account (net variances)	27 000	Loss for period	600
	123 000		123 000

WIP control account

Stores ledger	63 000	Finished goods stock	112 000
Wages control	28 000		
Fixed factory overhead	7 000		
Variable factory overhead	14 000		
	112 000		112 000

Wages control account

Wages accrued account	34 000	WIP	28 000
Labour efficiency variance	800	Wage rate variance	6 800
	34 800		34 800

Fixed factory overhead account

Expense creditors	6 000	WIP	7 000
Volume variance	2 000	Expenditure variance	1 000
	8 000		8 000

Variable factory overhead account

Expense creditors	11 000	WIP	14 000
Expenditure variance	2 600		
Efficiency variance	400		
	14 000		14 000

Finished goods stock

WIP	112 000	Cost of sales	96 000
		Closing stock c/fwd	16 000
	112 000		112 000

Cost of sales account

Finished goods stock	96 000	Cost P + L a/c	96 000



CASE STUDIES AVAILABLE FROM THE WEBSITE

The dedicated website for this book includes over 20 case studies. Both students and lecturers can download these case studies from the open access website. The authors of the cases have provided teaching notes for each case and these can be downloaded only by lecturers from the password-protected lecturer's section of the website.

The cases generally cover the content of several chapters and contain questions to which there is no ideal answer. They are intended to encourage independent thought and initiative and to relate and apply the content of this book to more uncertain situations. They are also intended to develop critical thinking and analytical skills. Details relating to the cases that are available from the website are as follows:

Anjo Ltd
Lin Fitzgerald, Loughborough University Business School
Variance analysis that provides the opportunity for the case to be used as a role-playing exercise.

Berkshire Threaded Fasteners Company
John Shank, The Amos Tuck School of Business Administration, Dartmouth College
Cost analysis for dropping a product, for pricing, for product mix and product improvement.

Berkshire Toy Company
D. Crawford and E.G. Henry, State University of New York (SUNY) at Oswego
Variance analysis, performance evaluation, responsibility accounting and the balanced scorecard.

Blessed Farm Partnership
Rona O'Brian, Sheffield Hallam University
Strategic decision-making, evaluation of alternatives, ethics, sources of information.

Bohemia Industries
Colin Drury, Huddersfield University Business School
The application of variable and absorption costing for internal monthly profit reporting.

Company A
Mike Tayles, University of Hull Business School and Paul Walley, Warwick Business School.
Evaluation of a product costing system and suggested performance measures to support key success factors.

Company B
Mike Tayles, University of Hull Business School and Paul Walley, Warwick Business School.
The impact of a change in manufacturing strategy and method upon product costing and performance measurement systems.

Dumbellow Ltd
Stan Brignall, Aston Business School
Marginal costing versus absorption costing, relevant costs and cost–volume–profit analysis.

Electronic Boards plc
John Innes, University of Dundee, and Falconer Mitchell, University of Edinburgh
A general case that may be used at an introductory stage to illustrate the basics of management accounting and the role it can play within a firm.

Endeavour Twoplise Ltd
Antony Head, Brenda McDonnell, Jayne Rastrick, Sheffield Hallam University, and Susan Richardson, University of Bradford Management Centre
Functional budget and master budget construction, budgetary control and decision-making.

Fleet Ltd
Lin Fitzgerald, Loughborough University Business School
Outsourcing decision involving relevant costs and qualitative factors.

Global Ltd
Susan Richardson, University of Bradford Management Centre
Cash budgeting, links between cash and profit, pricing/bidding, information system design and behavioural aspects of management control.

Gustavvson, AB
Colin Drury, Huddersfield University Business School
Alternative choice of cost centres and their implications for overhead assignments for various decisions.

Hardhat Ltd
Stan Brignall, Aston Business School
Cost–volume–profit analysis.

High Street Reproduction Furniture Ltd
Antony Head, Rona O'Brian, Jayne Rastrick, Sheffield Hallam University, and Sue Richardson, University of Bradford Management Centre
Relevant costs, strategic decision-making and limiting factors.

Majestic Lodge
John Shank, The Amos Tuck School of Business Administration, Dartmouth College
Relevant costs and cost–volume–profit analysis.

Merrion Products Ltd
Peter Clarke, University College Dublin
Cost–volume–profit analysis, relevant costs and limiting factors.

Moult Hall
Antony Head, Brenda McDonnell, Jayne Rastrick, Sheffield Hallam University, and Susan Richardson, University of Bradford Management Centre
Organizational objectives, strategic decision-making, evaluation of alternatives, relevant costs, debating the profit ethos, break-even analysis.

Oak City
R.W. Ingram and W.C. Parsons, University of Alabama, and W.A. Robbins, Attorney, Pearson and Sutton
Cost allocation in a government setting to determine the amount of costs that should be charged to business for municipal services. The case also includes ethical considerations.

Quality Shopping
Rona O'Brian, Sheffield Hallam University
Departmental budget construction, credit checking, environmental issues, behavioural issues and management control systems.

Rawhide Development Company
Bill Doolin, University of Waikato, and Deryl Northcott, University of Manchester
Capital investment appraisal involving relevant cash flows, uncertainty, application of spreadsheet tools and social considerations.

Rogatec Ltd.
Antony Head, Brenda McDonnell, Jayne Rastrick, Sheffield Hallam University, and Susan Richardson, University of Bradford Management Centre
Standard costing and variance analysis, budgets, ethics, sources of information.

The Beta Company
Peter Clarke, University College Dublin
Cost estimation involving regression analysis and relevant costs.

Traditions Ltd.
Antony Head, Brenda McDonnell, Jayne Rastrick, Sheffield Hallam University, and Susan Richardson, University of Bradford Management Centre
Relevant cost analysis relating to a discontinuation decision and budgeting.

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