Chapter 3
COSTING PRODUCTS AND SERVICES

Key Learning Objectives

By the time you have finished studying this chapter, you should be able to:

- implement the allocation and apportionment of overhead costs by traditional means;
- determine overhead absorption rates;
- make use of such rates in determining the costs of products and services and the value of closing inventory;
- critically evaluate such costs;
- evaluate the contribution of activity-based costing to the costing of products and services;
- utilise the marginal cost approach to the costing of products, services and inventory.

Introduction

Initially in this chapter we will concern ourselves with total absorption costing (TAC). This is a system for determining the full cost of products and services. The full cost of a product is made up of direct costs and a share of indirect costs (or overheads). In order to achieve full cost, a number of stages have to be undertaken, as follows:

1. All costs are subdivided into direct costs and indirect costs. Direct costs (primarily direct materials and direct labour) are traced directly to individual products.
2. Factory indirect costs are apportioned to cost centres.
3. The totals of the costs of service department cost centres are reapportioned to productive cost centres.
4. Budgeted overhead absorption rates are calculated for each of the production cost centres.
5. The budgeted absorption rates are applied to products and services in order to assist in calculating the full cost of the products or services.

Table 3.1 Examples of production and other overheads

Production overheads	Other overheads
Foremen's salaries	Marketing costs
Factory manager's salary	Head office salaries
Depreciation of factory equipment	Bad debts
Cost of heating for factory	Finance costs
Factory rent	Head office rent

Allocation and Apportionment of Overheads to Cost Centres

All costs can be subdivided into direct and indirect costs. Direct costs can be traced to each unit of output, and include items such as direct materials, direct labour and direct expenses. Indirect costs represent all other costs. They are also known as overhead costs. They may relate to production or they may be of a more general nature. Examples are shown in Table 3.1.

We will be concerned only with direct costs and production overheads in calculating the full cost of products and services as these costs specifically relate to production. The other overheads are not charged to each product but are, instead, charged to the profit and loss account for the year.

Production costs are allocated and apportioned to production cost centres. Examples of production cost centres are the machining department, assembly department, finishing department, production administration, and maintenance. Allocation of costs occurs when there is a clear link between a specific overhead and a specific department. Apportionment occurs when a clear link is absent and each department is charged with a fair share of overhead. For example, if the assembly department leases a specific machine, then the costs of the lease can be allocated directly to the assembly department. Contrast this with the costs of heating the factory; the costs of heating the assembly department cannot be separately identified. In this situation, the heating costs are apportioned to departments and the assembly department will be charged with a share of the total heating cost. Examples of apportionment bases are provided in Table 3.2.

We can now consider the application of such thinking to cost information. Table 3.3 gives information relating to a factory that manufactures desks. The factory contains four cost centres. The desks are physically worked upon in two of these cost centres, the assembly department and the finishing department. These are termed 'production cost centres'. The other two cost centres provide services for these two production cost centres. These are the maintenance department and the factory administration department. These are termed 'service cost centres'. As the service cost centres provide benefits to the

Table 3.2 Examples of overhead bases

Production overhead	Possible basis for apportionment
Foreman's pay	The number of employees in each cost centre, because the foreman's workload is likely to be influenced by the number of employees in each cost centre. Alternatively, a foreman may be required to make an estimate of the amount of time taken up by each of the cost centres.
Depreciation of equipment	This could be based upon the cost, or written-down value, of each item of equipment in the different cost centres. The reason for doing this is that depreciation is generally related to the cost of assets. Other things being equal, the more costly the asset, the greater the depreciation charge.
Factory heating	This apportionment may be based upon the floor area or volume of each cost centre as these factors are likely to determine the amount of heating required by each cost centre.
Factory rent	This is usually apportioned on the basis of the floor area of each cost centre.
Factory power	This could be apportioned on the basis of the number of machines in each cost centre, but a more sophisticated approach would be to take account of the power requirements of each machine and allow for this in apportionment.
Indirect wages	The apportionment could be related to the number of direct labour hours in each cost centre, or the number of indirect employees in each cost centre. If there are any part-time indirect employees, it will be necessary to take account of full-time equivalent employees.

production cost centres, the latter will in turn be required to bear the costs of the service cost centres.

The table shows the costs incurred by the factory and provides financial and statistical information relating to the cost centres that will allow us to allocate and apportion the production overheads to the four cost centres. As may be seen in Table 3.3, the total costs of the service cost centres are to be reapportioned equally to each of the two production departments.

We have now established the indirect costs and also the bases that should be used to allocate and apportion them to the four cost centres. This is carried out by means of an overhead analysis sheet. A completed overhead analysis sheet for 2005 is shown in

Table 3.3 Apportionment data

Indirect costs	Costs £	Apportionment basis	Production departments		Service departments		Totals
			Assembly	Finishing	Maintce.	Admin.	
Factory manager	35,000	No. of employees	15	10	5	5	35
Foremen	70,000	No. of employees	15	10	5	5	35
Indirect wages	56,000	Allocation	£37,500	£16,250	£8,000	£8,000	£56,000
Depreciation	25,000	Book values of plant and machinery	£200,000	£30,000	£20,000		£250,000
Heating	15,000	Floor area (sq. metres)	50	50	20	30	150
Power	8,000	Number of machines	6	1	1		8
Factory rent	7,500	Floor area (sq. metres)	50	50	20	30	150
Service departments		Equally to each production dept.					
Total	216,500						

Table 3.4. It may be seen that the indirect costs of £216,500 have been apportioned to the four cost centres, with the total of each cost centre's overheads shown at the foot of each column. At this stage one should check that the totals add up to the total of costs in the second column. A secondary apportionment is then carried out with the costs of the two service cost centres reapportioned to the production cost centres.

We have now completed stage 3 and apportioned the budgeted factory overheads to the two production cost centres, assembly and finishing. In this case, the service departments carry out work solely for the production departments, assembly and finishing, so the costs of the service departments are reapportioned directly. There will be cases when service departments carry out work for each other, and this increases the complexity of analysis.

At the next stage, stage 4, budgeted overhead absorption rates are calculated for each of the production cost centres. In this company, as Table 3.5 shows, the main factor of production in assembly is machinery, whilst the main factor in finishing is direct labour. Accordingly, machine hours will be used to absorb overheads in assembly and direct labour hours (DLH) in finishing. Each absorption basis is chosen because of the relative

Table 3.4 Budgeted overhead analysis for 2005

Cost	£	Apportionment bases	Production cost centres		Service cost centres	
			Assembly	Finishing	Maintenance	Admin.
Factory manager	35,000	Factory employees	15,000	10,000	5,000	5,000
Foremen	70,000	Factory employees	30,000	20,000	10,000	10,000
Indirect wages	56,000	Allocation	23,750	16,250	8,000	8,000
Depreciation	25,000	Book value	20,000	3,000	2,000	
Heat	15,000	Floor area	5,000	5,000	2,000	3,000
Power	8,000	Machines	6,000	1,000	1,000	
Rent	7,500	Floor area	2,500	2,500	1,000	1,500
Sub-totals	216,500		102,250	57,750	29,000	27,500
Reapportionment of maintenance		Equally	14,500	14,500	–29,000	
Reapportionment of admin.		Equally	13,750	13,750		–27,500
Totals	216,500		130,500	86,000		

Table 3.5 Budgeted annual activity

Assembly	Finishing
2,500 DLH	6,500 DLH
6,000 machine hours	200 machine hours

importance of machine hours or labour hours in each cost centre. The budgeted annual activities given in Table 3.5 will now form the basis of overhead absorption rates in each cost centre, as shown in Table 3.6.

At stage 5, the overhead costs of the departments will be incorporated into products using these budgeted absorption rates. As we saw at the start of this chapter, a product's costs are made up of direct costs and indirect costs. Information about two products is shown in Table 3.7. Using this information, we can calculate the full cost of each product by adding to the direct cost a share of factory overhead by utilising the budgeted absorption rates and the information regarding hours for each product. This is summarised in Table 3.8.

Table 3.6 Overhead absorption rates

	Machining	Assembly
Budgeted overheads £	130,500	86,000
Budgeted activity (hours)	6,000	6,500
Budgeted absorption rate	£130,500/6,000	£86,000/6,500
per hour	= £21.75 per machine hour	= £13.23 per DLH

Table 3.7 Direct costs and production times

	Product A	Product B
Direct costs	£23.50	£14.75
Machine hours (Machining)	4	4
DLH (Assembly)	6	3

Table 3.8 The full cost of products A and B

	Product A £	Product B £
Direct costs	23.50	14.75
Overheads		
Machining		
4 hours at £21.75 per hour	87.00	87.00
Assembly		
6 DLH at £13.23	79.38	
3 DLH at £13.23		39.69
Totals	£189.88	£141.44

The Over- and Under-Absorption of Overheads

We saw above that the calculation of budgeted overhead absorption rates for both the assembly and finishing departments was a key step in the calculation of ‘full cost’. As we saw, this is calculated as:

$$\frac{\text{Budgeted overhead department costs}}{\text{Budgeted departmental activity (machine hours or DLH)}}$$

Absorption rates are normally calculated before the start of the accounting year. As you can see, this requires an estimate of costs and an estimate of activity and it aims to absorb all costs by applying the budgeted absorption rate to production during the year. However, this will only occur if actual figures are the same as budgeted figures. However, such equivalence between budget and actual is not guaranteed. It is more than likely that actual costs will differ from budgeted costs and/or actual activity will differ from budgeted activity. Using the machining department for illustration, the effect of differences between budget and actual is illustrated below.

As we have seen, the budgeted absorption rate in the machine department for 2005 is £21.75 per machine hour. During January 2005 for the machine department we have:

Actual machine hours: 480 hours
Actual overhead costs: £10,875

We can now consider the effect of this on the absorption of overheads in January (see Table 3.9).

Table 3.9 Overhead absorption in January

		£
Overhead absorbed into production	480 hours × £21.75 per hour	10,440
Actual overhead cost		10,875
Under-absorption of overhead		475

The under-absorption (also termed under-recovery) can either be carried forward to the next month, or written off to a monthly profit and loss account. During the year, some months will experience under-absorption and others over-absorption so that, hopefully, they will cancel out by the year end. If, at the end of the year, the cumulative figure is a under-absorption then this means that the company's profit will be reduced as these under-absorbed overheads that cannot be charged to products will be charged as an expense to the profit and loss account of the business. The opposite applies if there is an over-absorption, which will offset costs in the profit and loss account.

Reasons for the Apportionment and Absorption of Overheads

Stock Valuation

The TAC technique ensures that all production, including work in progress, incurs a share of production overhead. For work in progress, the amount of overhead will reflect the degree of completion of the products. Closing stock is valued at full cost, including direct costs and a share of production overhead. One consequence is that a share of the overhead costs of one accounting period is transferred via closing stock into the following accounting period. This technique is accepted by taxation authorities and is accepted in financial reporting as an acceptable methodology for the valuation of closing stock and work in progress.

Product Costing

The process identifies the full cost of a product and this itself permits the calculation of product profitability by comparing selling price with this full cost, ignoring the non-manufacturing costs of the company. The product cost can also act as a floor when setting the price of the product.

Cost Control

Cost apportionment and reapportionment are initially carried out at the budgeting stage. They thus make production and service cost centre managers aware of the budgeted costs at an early stage. Indeed, the process of budgeting overheads forces managers to review these costs before they are integrated into the budget for the company. Thus it should assist managers in controlling their own budgets.

Justification for Reimbursement of Costs

Some government grant-funded activities relate the ceiling of grant to the full cost of the activity being funded. The process for calculating the full cost needs to be verifiable and capable of exposure to audit inspection. To its credit, the apportionment/absorption system lays a clear audit trail from the collection of costs through to the absorption of costs into products. It is an accepted and well-understood process.

Production Overheads are Product-Related

It is argued that products cannot be manufactured unless overheads are incurred. Indeed, the underlying assumption is that production overheads are regarded as product costs just as direct costs are. Indeed, the only reason to incur overheads is in order to manufacture products that mat be sold and earn a profit.

Criticisms of Apportionment and Absorption

We identify the following four criticisms:

1. The accuracy of product costs calculated under absorption costing is highly suspect. This is a consequence of the rather arbitrary apportionment of costs to cost centres. Changing the apportionment basis of any one overhead cost would change

a department's total costs and, therefore, its budgeted absorption rate and, of course, the full cost of products. It follows that the practice of using the product cost as a basis for constructing a product price is flawed because the product cost itself results from a more or less arbitrary cost apportionment process.

2. In the illustration above, we have used different methods for absorbing overheads in assembly and manufacturing, respectively. This is more accurate than, say, using one overall rate; for example, apportioning total production overheads on the basis of direct labour hours so that:

$$\frac{\text{Overhead costs}}{\text{Direct labour hours}} = \frac{\pounds 216{,}500}{9{,}000} = \pounds 24.05 \text{ per DLH}$$

   The revised rate per DLH of £24.05 represents a significant increase over the assembly department rate of £13.23 per DLH. A study by Drury and Tayles (2000) found that a very small percentage of firms in the UK used a single plant-wide rate for absorbing overheads.

3. The system uses broad averages to spread costs over products. The arbitrariness in the process can lead to product undercosting or product overcosting. In undercosting a product consumes a relatively high level of resources but is reported to have a relatively low total cost. Overcosting implies that a product's consumption of resources is far lower than its reported cost. Next in this chapter we discuss activity-based costing, which may offer a way of refining the costing system.
4. In the short run many of the factory overheads will be fixed, and marginal costing offers a way of dealing with short-run decisions involving costs; this is considered later in this chapter.

Activity-Based Costing

The system of absorption costing has evolved from the cost accounting thinking and systems that were established in Victorian times. The conceptual basis and the systems allied to this were established in an industrial environment in which the following features were endemic: direct labour costs and direct material costs were the dominant factory costs; overheads were relatively small; information processing costs were high; there was an absence of intense global competition; there were low levels of automation and a relatively limited product range. The cost accumulation system, which was developed in order to assemble product costs in the nineteenth-century environment, was total absorption costing. As we have seen, it attaches traceable direct costs (labour and materials) directly to products and then apportions factory overheads to products in a systematic but rather arbitrary fashion, with the proportion of overheads usually following the volume of direct labour activity in a product. The underlying philosophy is that products cannot be produced without incurring overheads so they must bear their share of overheads; most overheads are time-related (e.g. factory rent and foremen's salaries) so the apportionment is usually linked to the time taken by labour to produce output.

However, during the late twentieth century absorption costing was increasingly criticised by academics, for example Zimmerman (1979). During the last 20 years, the following criticisms have been made:

- There has been a systematic distortion of product costs caused by the perpetuation of convenient but inappropriate volume-based methods of production overhead apportionment.
- There has been a lack of visibility and transparency given to increasingly important areas of overhead consumption.
- Non-factory overheads have been neglected even though these compromise significant elements of overhead expense.
- Decision making requires variable cost information, which traditional cost systems have been unable to provide.

In 1987, Johnson and Kaplan published a seminal work, *Relevance Lost: The Rise and Fall of Management Accounting*. They indicate two major environmental changes which traditional management accounting thinking had failed to address. The first of these was the phenomenal growth in the value of production overheads caused by factors such as investment in automation and research and development. As the overheads had grown in significance, the direct labour costs had dwindled and were commonly only a small proportion of overhead costs. It was now more evident than ever that direct labour represented an inadequate basis for the apportionment of overheads. The second factor was the increasing competitiveness of the world economy. In order to compete effectively, firms often adopted practices with which traditional product costing was unable to work. For example, firms commonly met niche needs with short production runs and the same production line was commonly reconfigured for a different model. The traditional methodology was simply incapable of producing accurate and representative product costs in this environment. Yet the penalty for incorrectly costing and thereby incorrectly pricing products in this marketplace was very severe. Johnson and Kaplan (1987) proposed a different way of thinking about costs and advanced a methodology termed *activity-based costing* (ABC),which would address many of the weaknesses of the traditional system.

The work was extremely well received in academic circles. Additionally, the environmental changes in the world economy were such as to raise hopes that the practitioners responsible for developing and implementing systems in the corporate world would accept it. In the past academic criticism of industrial accounting practice has often been ignored because of the perceived irrelevance of academic research by practising accountants. However, in this case, the commercial connections of the academic home of Johnson and Kaplan (1987) were such as to place the proposals at the centre of corporate thinking. Both are based at Harvard Business School, which has been associated with strategic developments in some of the largest companies in the United States. Additionally, many of the ideas of ABC may be linked to the universally accepted strategies of corporate comparative advantage developed and articulated by Michael Porter (1985) at Harvard.

Absorption costing

Total overhead costs e.g.	Apportionments to factory departments	Departments	Absorption by DLH or machine hours	Product cost
Rent	→	Machining	Machine hours	→
Power etc.	→	Assembly	Labour hours	→

ABC

Total overhead costs e.g.	Collected according to activities	Activity cost pools e.g.	Cost driver rates e.g.	Product cost
Staff costs	→	Purchase of raw materials	Cost per purchase order	→
Equipment costs	→	Machine set-up	Cost per set-up	→
Power etc.	→	Machining products	Cost per machine hour	→

Figure 3.1 Absorption costing and ABC compared

Overview

Some of the key differences between traditional absorption costing systems and ABC are highlighted in Figure 3.1.

In absorption costing, as we have seen, overhead costs are apportioned to production departments. There will usually be few of these. In ABC, on the other hand, activities that contribute to production are first defined; there will be a number of these. The costs of each activity are collected into an activity cost pool that represents the costs of undertaking the specified activity for a year. Activities include: machine set-ups (concerned with setting up machinery for production); purchase order costs (the costs of ordering raw materials); and inspection (the costs of quality control). Costs may be classified into support activities and production process activities. The former activities include inspection and purchase order costs. The latter activities include assembly, machining and finishing, and these may be synonymous with production departments. Within absorption costing the costs of support services are normally apportioned to production departments and amalgamated with all other costs, whereas in ABC they stand alone and are separately allocated as product costs.

Absorption costing normally uses one or two bases for absorbing overheads, namely DLH or machine hours. In ABC, on the other hand, there will be a range of different cost drivers. Cost drivers are factors that cause costs of the activity to increase; the direct cause–effect link is not present in absorption costing. Examples of cost drivers are shown in Table 3.10.

Table 3.10 Cost pools and cost drivers

Activity cost pool	Cost driver
Purchase of raw materials	The number of purchase orders
Machine set-up costs	The number of set-ups
Cost of machining products	The number of machine hours
Inspection costs	The number of inspections carried out

Each cost driver will be associated with a cost driver rate that will be used to calculate the amount of activity pool resource cost to be charged to each product line. A cost driver rate is calculated by:

$$\frac{\text{The costs of the activity cost pool}}{\text{Number of cost drivers for the activity}}$$

Illustration

Eiger Ltd. makes two different models of ice axe using the same factory and equipment. They are the Popular, a mass market axe, and the Expert, for the very experienced mountaineer. The annual production overhead of £92,000 has been analysed over five activities as is shown in Table 3.11. The cost drivers have been identified and counted and the cost driver rates have been calculated.

Table 3.11 Annual production overhead for Eiger ice axes

Activity	Activity Cost Pool £	Cost driver	Number of cost drivers	Cost driver rates £
Production scheduling	15,000	The number of production runs	50	£300 per production run
Buying raw materials	16,500	The number of purchase orders	110	£150 per purchase order
Material set-ups	18,000	The number of set-ups	180	£100 per set up
Machining products	24,000	Machine hours	8,000	£3 per machine hour
Quality control	18,500	The number of inspections	370	£50 per inspection
Total costs	92,000			

During the year Eiger Ltd. plans to make 3000 of the Popular model and 1000 of the Expert. Production of the Expert is much more complex and it is produced in smaller batches and in shorter production runs. The Popular requires 1 hour and 40 minutes of machine time per product, whilst the Expert requires 3 hours. Direct costs per ice axe are as follows:

	Popular £	Expert £
Direct Labour	8	12
Direct materials	12	15
	20	27

The annual number of cost drivers is split between the two product lines as shown in Table 3.12.

Table 3.12 Cost driver breakdown

		Number of cost drivers	
Cost driver	**Total**	**Popular**	**Expert**
Production runs	50	20	30
Purchase orders	110	60	50
Set-ups	180	70	110
Machine hours	8000	5000	3000
Quality control	370	120	250

We can now use the information about cost driver rates and the number of cost drivers in each product line to calculate the activity-based cost for one Popular and one Expert ice axe (see Table 3.13).

Overcosting and Undercosting of Products

In our criticisms of absorption costing we outlined that it may result in some products being overcosted relative to their resource consumption and others undercosted. ABC is likely to reduce the likelihood of this because it is a much more refined system. With regard to Eiger Ltd., absorption costing systems would have used a machine hour rate and this would have been:

$$\text{Production absorption rate} = \frac{£92{,}000}{8000 \text{ machine hours}}$$
$$= £11.50 \text{ per machine hour}$$

Table 3.13 Activity-based cost per ice axe

		Popular		Expert	
Activity	**Cost driver rate**	**Number of cost drivers**	**Total cost £**	**Number of cost drivers**	**Total cost £**
Production scheduling	£300 per production run	20	6,000	30	9,000
Purchasing raw materials	£150 per purchase order	60	9,000	50	7,500
Machine set-ups	£100 per set-up	70	7,000	110	11,000
Machining products	£3 per machine hour	5000	15,000	3000	9,000
Quality control	£50 per inspection	120	6,000	250	12,500
Total cost			£43,000		£49,000
Number of ice axes produced			3,000		1,000
			£		£
Overhead cost per ice axe			14.33		49.00
Add direct costs			20.00		27.00
Total costs per ice axe			34.33		76.00

The total product costs utilising absorption costing and their comparison with ABC product costs are shown in Table 3.14. This under- and overcosting is referred to as cross-subsidization. Popular ice axes are cross-subsidizing Experts as they are bearing some of the costs of the latter, amounting to £2.92 per Popular. If the company uses product costs for decision making, for example as a basis for determining a product price, then under absorption costing Experts may be sold too cheaply.

Types of Activity Cost Pools

Cooper (1990) classified manufacturing activities into four distinct levels:

1. *Unit-level activities*. These are performed each time a unit of the product or service is produced. They consume resources directly in proportion to production output.

Table 3.14 Product costs

	Popular £	Expert £
Overhead		
Popular £11.50 × 1.667 hours	17.25	
Expert £11.50 × 3 hours		34.50
Direct costs	20.00	27.00
Product cost using absorption costing	37.25	61.50
Product cost using ABC	34.33	76.00
Absorption overcosting of Popular	2.92	
Absorption undercosting of Expert		14.50

An example is given by machine running costs with a cost driver of machine hours as the increase or decrease in costs is caused directly and proportionately by changes in production.

2. *Batch-level activities*. These are performed each time a batch of goods is produced – for example, each time a machine is set up for a different production run. Batch-level activities are fixed for all units within the specific batch and must be averaged over the number of units produced to produce a cost per unit.
3. *Product-sustaining activities*. These are performed so that production of a specific product can take place, for example, maintaining or upgrading product specifications, or product design. These costs will be incurred irrespective of the number of batches or units that are produced.
4. *Facility-sustaining activities*. These are incurred in order that, for example, the factory can engage in manufacture, and this includes things like the plant manager and factory rents. Such costs cannot be traced to individual products and, in ABC, they are shown as a deduction from the total gross profits of production.

The Benefits of ABC

Product Costing

As we have seen, the costs obtained under ABC are likely to be more accurate in reflecting underlying resource consumption than is absorption costing. This is particularly important in a complex organisation, with many products operating in a range of competitive markets. Bhimani and Piggott (1992) found that factory managers found ABC information to be valuable in allowing them to identify overhead cost reduction opportunities. There is a summary of this article at the end of the chapter.

Decision Making

It can be argued that the product costs are valuable for decision making. Although the costs include overheads, such overheads are calculated using cost drivers that are based upon a cause–effect relationship between activity cost pool and the associated cost driver.

Activity-Based Management

ABC, through the processes of pooling of activity costs and the identification of cost drivers, can lead to a range of applications. These include the identification of spare capacity and the fostering of cost reduction by comparing the resources required under ABC with the resources that are currently provided. This provides a platform for the development of activity-based budgeting in which the resource relationships identified by ABC are used to project future resource requirements. A study by Innes and Mitchell (1995) in the United Kingdom reported that the cost management applications of ABC by firms outweighed the product costing applications.

Service Organisations

These organisations, such as banks, hospitals and government departments, have very different characteristics than manufacturing firms. Service organisations have almost no direct costs, most of the costs are overheads and they do not hold stocks of service as the service is consumed when it is produced. Absorption costing has generally been considered inappropriate for these organisations, whereas ABC offers the potential of benefits from improved decision making and cost management. Drury and Tayles (2000), in a UK survey, found that 51% of the financial and services organisations surveyed had implemented ABC, compared with only 15% of manufacturing organisations.

An Improved Role for the Management Accountant

ABC and activity-based management allow the management accountant to play a key part in maximising value from resources because of the level of understanding of key activity and cost information.

The Problems with ABC

1. Batch and product sustaining activities will need to be averaged over all units produced in order to arrive at product costs. This may give the false impression that there is a direct relationship between marginal changes in output and these costs.
2. These systems are more complex than absorption costing and are more expensive to operate. They also take a number of years to develop. All firms should consider the costs and benefits of ABC, and for small companies in particular the costs may outweigh the benefits.

3. Hopper *et al*. (2003) warn of the dangers of implementing western management accounting practices in less developed countries. There is a summary of the article at the end of this chapter.

Marginal or Variable Costing

Marginal costing is based upon the segregation of costs into two groups, variable costs and fixed costs. As you learned in Chapter 2, variable costs are assumed to vary directly in proportion with output in the short term. Examples include fuel for motor vehicles and direct material costs. Fixed costs remain constant over a wide range of activity levels for a specified period of time, and they are not affected by changes in output. Examples include rents of buildings and managers' salaries.

Marginal costing assumes that: variable costs are product-related because they vary as production is increased or decreased, and that fixed costs are time-based as they relate to a specific accounting period.

Contribution

The concept of *contribution* is central to marginal costing. Contribution is defined as selling price less variable costs. If production and sales are both expected to be 5000 in a period and selling price is £15, variable costs are £9 and fixed costs are £24,000 then:

	Per unit £	Totals £
Sales	15	75,000
Variable costs	9	45,000
Contribution	6	30,000
Fixed costs		24,000
Net profit		6,000

As can be seen, the contribution does not represent profit as we have to consider the fixed costs of the operation. We can regard the contribution as contributing to the fixed costs and net profit of the organisation. In order to make a profit, the contribution must exceed the fixed costs of the period.

Break-Even and Target Contribution

The unit contribution can be used to identify the break-even output of the company. Break-even is a situation in which a company makes neither profit nor loss. At break-even total contribution will exactly equal total fixed cost and we can find the break-even sales level quite easily by means of the following formula:

$$\text{Break-even} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} = \frac{£24{,}000}{6} = 4000 \text{ units}$$

When 4000 units are sold, contribution will amount to (4000 × £6 =) £24,000, which is equal to total fixed costs.

In an extension of this, unit contribution also allows the identification of the number of sales units required to earn a target profit. In this case total contributions must fully cover fixed costs and earn the target profit. If the company in this case desires a net profit of £12,000 then the number of units that it must produce and sell is given by the following formula:

$$\text{Required units} = \frac{\text{Fixed costs and target profit}}{\text{Contribution per unit}} = \frac{£24{,}000 + £12{,}000}{6} = 6000 \text{ units}$$

The following statement demonstrates that the target net profit of £12,000 will be earned if 6000 units are produced and sold:

	Per unit £	**Totals £**
Sales (6000 units)	15	90,000
Variable costs (6000 units)	9	54,000
Contribution (6000 units)	6	36,000
Fixed costs		24,000
Net profit		12,000

Margin of Safety

The margin of safety is the difference between the budgeted (or actual) output and the break-even output. Thus, at 6000 units of output the margin of safety is 2000 units. Output can fall by 2000 units before it falls to break-even at 4000 units.

The margin of safety can also be stated in percentage terms:

$$\frac{\text{Margin of safety}}{\text{Budgeted output}} \times 100 = \frac{2000 \text{ units}}{6000 \text{ units}} \times 100 = 33\%$$

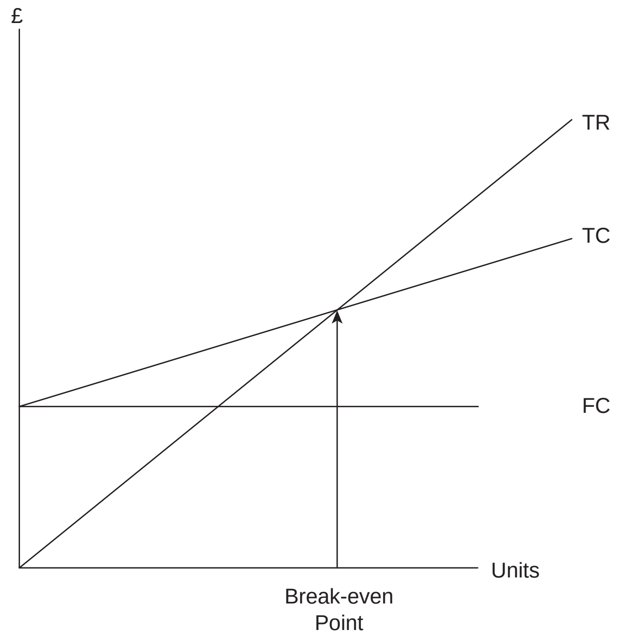

Figure 3.2 Break-even chart

Break-Even Charts

The relationship between revenues, variable costs and fixed costs can be summarised in a break-even chart, as is demonstrated in Figure 3.2. It shows the break-even point where total revenue (TR) is equal to total costs (TC, at 4000 units in our example). Total costs represent the sum of variable costs and fixed costs (FC) at all levels of output.

There are some key assumptions underpinning the construction of a break-even chart. The most important of these is the linearity assumption, which is that variable costs and sales revenue are constant per unit of output and can be represented by straight lines. In Figure 3.2 it also assumes that fixed costs are at the same level throughout the range of activity. The previous chapter discussed stepped fixed costs, and these can be easily accommodated within the diagram.

The assumption of linearity of the cost and revenue functions may be considered to be the Achilles' heel of the break-even chart. However, the concept of the 'relevant range' is important here. It states that a manager will not be interested in the whole range of the break-even chart but in a relevant area, possibly from break-even to the budgeted level of output and sales, and as long as the lines are linear within that range, that is sufficient for purposes of decision making.

One benefit of the break-even chart for managers is that they can easily assimilate the information presented and the relationships between the key variables. It is also useful for displaying the range of profits and losses and it may be much easier for non-financial managers to understand than tables of data.

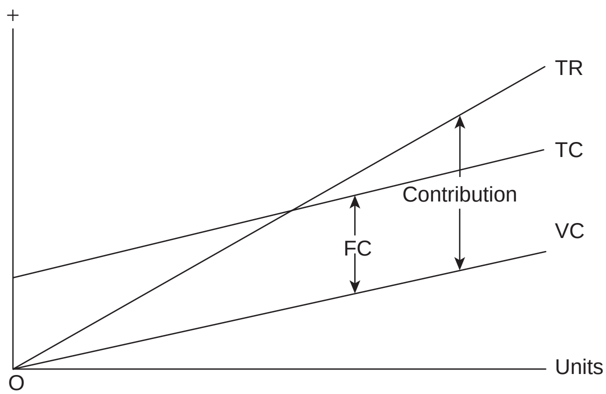

Figure 3.3 Contribution chart

A contribution chart is shown in Figure 3.3. This chart shows the total contribution as the difference between the total revenue and the variable cost (VC) lines. Fixed costs are represented by the difference between the variable cost and total cost lines. Break-even is at the junction of total revenue and total cost.

Marginal Costing as a Cost Collection System

The basis of marginal costing as a cost collection system is as outlined above. First, costs are broken down into fixed costs and variable costs. Secondly, fixed costs are regarded as period costs and not as product costs and are not carried forward in closing stock. In consequence, the value of closing stock will be less than under absorption costing, in which closing stock contains a share of factory costs, irrespective of whether they are fixed or variable. Marginal costing is relatively infrequently used as a cost collection system.

Illustration

McCarthy & Sons produce wicker baskets, and the firm uses marginal costing as a cost collection system. Data for the first month of production are as follows:

Unit selling price	£4	Production	6,000 baskets
Unit variable cost	£1.50	Sales	5,000 baskets
Fixed production overhead	£9,000	Closing stock	1,000 baskets
Fixed selling costs	£3,000		
	£		
Sales (£4 × 5,000)	20,000		

Costs of production		
Variable costs (£1.50 × 6,000)	9,000	
Less closing stock (£1.5 × 1000)	(1500)	7,500
Contribution		12,500
Fixed costs		
Production costs	9000	
Selling costs	3000	12,000
Net profit		500

As may be seen, closing stock is valued at the variable costs of production. By contrast, the closing stock valuation in absorption costing would, as well as the variable costs, also have included a proportion of the fixed production overheads. This amounts to (1000/6000 × £9000 = £1500) because the closing stock of 1000 units is one-sixth of production and should therefore bear one-sixth of fixed costs. This would increase closing stock from £1500 to £3000 and increase this period's profit from £500 to £2000. However, in the next period the absorption costing profit will be lower than the marginal costing profit because the former is carrying forward a higher cost to the next accounting period.

Conclusions

This chapter makes the following points:

- Absorption costing is an accepted method of costing products and inventories. There is a well-established multi-stage process to apportion and absorb overheads into production.
- It has advantages, but is flawed from a decision-making perspective.
- ABC offers improved product costing and an opportunity to improve decision making and cost management.
- ABC is complex, expensive and time-consuming. It is unlikely to be suitable for small businesses but is suitable for service sector organisations.
- Marginal costing can be used in decision-making, emphasising cost behaviour and contribution. The relationships between variables can be summarised in a break-even chart or a contribution chart. Marginal costing can also be used as a cost collection system.

Summary

The chapter has examined three approaches to product costing: absorption costing, activity-based costing and marginal costing. Absorption costing is widely used in practice, but its crude approach to costing means that it has significant weaknesses. Activity-based costing uses the ideas of cost pools and cost drivers and offers a way of overcoming some of the weaknesses of absorption costing. Marginal costing, the third approach, may be used in two ways: in decision making and in cost collection. It emphasises cost behaviour, the importance of differentiating between variable and fixed costs, the concept of contribution and that of break-even.

Recommended Further Reading

Bhimani, A. and Pigott, D (1992) 'Implementing ABC: a case study of organisational and behavioural consequences', *Management Accounting Research*, 3: 119–132.

The authors carry out field study research within a pharmaceutical manufacturing company, Evans Medical. The company manufactures vaccines, pharmaceuticals and 'over the counter' products; in total the company manufactured 350 products and had a turnover of £50 million. In the study the authors make use of interviews and document analysis and the study was conducted over an eight-month period.

The aim of the research is to explore the behavioural and organisational consequences that can arise in a company upon the implementation of ABC and to examine such consequences from the perspective of predefined expectations about a change in an accounting system. The study commenced with the company's decision to introduce ABC and ended at a stage when the new accounting system was running in parallel with the old.

The study examines the company's rationale for installing ABC. The company had come to the conclusion that its existing cost accounting system was inadequate in terms of product costs and in the production of broader management information. The aims of implementing ABC were to produce more accurate product costs, to produce regular cost and volume reports and to identify those activities that were driving costs to permit more effective cost control and product improvement.

The article goes on to document the results from introducing the system. In summary, the new system appeared to produce more accurate product costs that were also in line with management expectations. Moreover, the ABC system provided information enabling management to reduce costs and obtain improvements, again in line with expectations.

The article then goes on to discuss the behavioural and organisational consequences that followed the implementation of ABC. The first of these relates to the perceived legitimising of the accounting function. ABC requires accountants to gain 'an appreciation of manufacturing processes, operational issues and production activities and had created the perception among factory and head office managers that the accounting data emanating … was now more firmly grounded in organisational processes' (Bhimani and Piggott, 1992: 127). Secondly, ABC information was capable of being used by managers to support their own efforts to derive economies at the factory level. The previous system had been unintelligible to them, but ABC information was intelligible and was used by factory managers to legitimise their decisions; it also improved communication by providing line managers and accountants with a common language. Finally, it raised understanding of product profitability among factory managers, and their enhanced understanding produced a broad shift in the balance of power from sales to factory. Sales managers had played no part in the introduction of a new system and did not understand the significance of the information that was being produced.

Hopper, T., Tsamenyi, M., Uddin, S. and Wickramasinghe, D. (2003) 'The state they're in', *Financial Management*, June: 14–19.

Hopper *et al*. consider the relevance of western management accounting trends and ideals in the context of less developed countries (LDCs). They argue that the effective internal and external financial controls that are assumed by policy makers (e.g. those within countries granting aid to LDCs) often do not occur in practice. They claim that often the market-based reforms insisted upon by policy makers may frustrate rather than facilitate appropriate development. This, in turn, is likely to facilitate a lack of transparency, poorer employment conditions, fraudulent activity, etc.

Hopper *et al.* argue that, rather than requiring specifically designed management accounting systems, the LDCs should manage well with 'imported' technology. The real problem, they argue, is not that effective management accounting systems are not available or in place, but that they are either ignored or applied in unintended ways. Hopper *et al.* continue that the special types of risk and uncertainties specific to developing economies can lead to short-termism, compounded by political volatility. They explain that the problems of obtaining sufficiently rich information systems, and skilled, committed employees may be beyond the reach of LDCs, and unskilled personnel may be required to carry out a wide variety of tasks simultaneously. Effective and honest corporate governance cannot be assumed in all such environments, the instability of government, and the level of corruption within officials often being crucial factors.

The valuation of companies (and the use of associated management accounting methods) is not a straightforward matter where stable markets do not exist and where regulation is not complied with. Additionally, Hopper *et al.* question whether the various fashionable theories regarding the interface of culture and management accounting apply in such LDC environments, as the basic theoretical assumptions of such theories are unlikely to be relevant.

Hopper *et al.* suggest a 'package' of possible areas for future research and development to overcome the problem of the lack of 'fit' of recognised mainstream management accounting ideas within LDC environments. Amongst these areas, Hopper *et al.* include:

- the relationships between management accounting, auditing and external regulation;
- the study of types of enterprise that are uncommon or poorly researched within western management accounting (e.g. plantations, small family-run firms);
- ways of measuring performance according to criteria such as poverty reduction, rather than profit maximisation, shareholder value maximisation, etc.;
- budgeting within LDC governments;
- the effects of cultural, political and ethnic issues particular to LDC economies;
- the roles of transnational bodies such as the World Bank.

Case Study: Billy Griffiths

Billy Griffiths is the newly appointed management accountant for Hopeless Ltd. The company has an appalling history in terms of its budget procedures and processes, with widely fluctuating results over the three years of its existence. This situation led to Billy's appointment, and his key initial task is to sort out these problems.

The company manufactures double glazing, making three products – windows, doors and UPVC garage doors. These products are manufactured in three production departments which are supported by two service departments – a canteen and a maintenance unit.

Billy has had some success in his first three months with the company, having been able to calculate direct material costs and direct labour costs per unit. He is willing to admit, however, that some of the basic data on which he worked is rather dubious, although sufficiently robust to make a start.

His next task is to turn to the allocation and apportionment of overheads and the calculation of appropriate hourly rates to serve as a basis for pricing. He has obtained the following information to make his judgements:

	Windows	Doors	Garage doors
Production (units)	5,000	2,500	1,250
Prime Costs (£ per unit)			
Direct materials	50	75	150
Direct labour			
Machine shop	12	22	45
Assembly	26	40	64
Machine hours per unit	3	5	10

	Machine shop	Assembly shop	Canteen	Maintenance unit	Total
Budgeted overheads (£)					
Allocated overheads	35,000	17,650	21,000	15,500	89,150
Rent and rates					32,450
Depreciation					25,000
Book value of machinery	250,000	350,000	50,000	45,000	
Number of employees	12	25	5	3	
Floor area (sq. metres)	4,500	5,500	1,500	500	

It is estimated that 65% of the maintenance section's time is spent in the machine shop, and the balance in the assembly shop.

Billy is too busy to do the actual calculation and, as his assistant, the task has landed on your desk.

1. (a) Compile the spreadsheet for the above data, ensuring total flexibility if figures change.
   (b) Calculate a machine hour rate for the machine shop.
   (c) Calculate an overhead rate based on a percentage of direct wages.
   (d) Calculate the budgeted overhead cost of a unit of each of the products.
2. Flex the model by increasing all costs by 10% and see what happens to your results. What impact will this have, should this situation arise?
3. Management are aware that Billy is undertaking this process and are concerned about the new process of apportioning overheads and the use of spreadsheets. Advise them of the advantages and disadvantages of the new methods by specifically contrasting the new process with the historical methods of managing overheads.

Case Study: Jim Davies

Jim Davies is the manager of one of six large distribution warehouses for Mars & Spars, a multinational clothing and footwear chain store. Jim's warehouse operates as a profit centre whereby purchasing officers based within his warehouse buy in items under appropriately negotiated contracts and 'sell' them on to the company's UK-based stores, although occasionally the goods can be exported. These are his 'customers'. Suppliers are both UK and overseas companies.

Goods issued by Jim's warehouse are charged to his 'customers' at the agreed contract price plus variations for agreed factors such as inflation. Any cost outside the contract price plus agreed variations are borne by the supplier. The charge to Jim's customers is the cost charged to Jim plus 5%. This is thus effectively Jim's performance measure as at the end of the year his warehouse must show a 5% 'profit' after allowing for all costs. This profit margin determines not only Jim's performance-related pay bonus but also that of every person who works in the warehouse and Jim's distribution network. It also is a factor in determining Jim's promotion chances.

Jim is feeling aggrieved. Every year for the past three years his operating surplus has failed to achieve the necessary 5% target. This has resulted in little or no performance-related pay and he is under pressure from his senior managers to explain why he is failing to perform – particularly as the other five warehouses have all achieved their targets (and more in some cases). Jim conjectures that the way in which the company allocates and apportions overheads to his warehouse causes the failure to achieve targets.

The following summary figures indicate the position for the last three years:

	2004 £000s	2003 £000s	2002 £000s
Sales	10,000	9,500	9,250
Cost of sales	7,500	7,020	6,950
Gross profit	2,500	2,480	2,300
Expenses			
Operating costs	1,800	1,780	1,700
Central overheads	400	350	200
Net profit	300	350	400
Percentage return	3	3.7	4.3

At present the company uses the following definitions of overheads:

- Corporate overheads – costs of board meetings, secretarial staff, board members salaries and expenses, etc.
- Technical support – financial, legal and personnel support, including such functions as business planning, financial advice on budgets, equal opportunities policy advice, etc.
- Buildings – costs for every building owned or occupied by the company.

All these overheads are charged to a trading account for each section – legal, finance, personnel, IT etc. – and then charged to a frontline service such as Jim's warehouse on the basis of a staff time analysis for each division. Staff in the support departments fill in an individual timesheet every three years. They are asked to estimate the amount of time they spend on each activity of the company and then these time sheets are analysed and used as the basis to apportion costs in the appropriate trading account. The last time sheet analysis was completed in 1990.

With buildings, all costs for all buildings are allocated to one central building account. These are then apportioned to all departments and functions on the basis of floor area occupied. For central overhead departments, the final costs are apportioned to all front-line services such as warehouses on the basis of the staff time analysis.

The net result of this process is that all costs of the overhead departments are fully apportioned to frontline departments such as warehouses.

Having read and analysed the above case:

(a) Do you think the issue of overhead allocation is important to companies?
(b) Why do you hold your point of view?
(c) Identify what, if anything, is wrong with the above system.
(d) What alternatives do you think might exist to the above?
(e) Do you agree with Jim that overheads are the cause of all his problems?
(f) How would you go about implementing any alternative?

Questions

1. Spot Ltd. produces three products, X, Y and Z in three production departments: Moulding (Dept. M), Assembly (Dept. A) and Finishing (Dept. F). It also has two service departments responsible for repairs and maintenance (Dept. R) and for development and research (Dept. D).

   Employees in Dept. R are paid total salaries of £24,000 per annum and complete timesheets to account for their time. Departments M, A, F and D utilise its services in the ratio 70:20:8:2 respectively.

   Dept. D studies improvements in working practices and product designs. The salary costs of this department total £20,000 per annum, and its work is expected to benefit the three production departments equally.

   The management accountant has estimated that the following factory overheads (excluding the salaries described above) will be incurred in the coming year:

	Note	£000's
Rent and rates		240
Electricity	1	75
Establishment costs		200
Plant insurance		60
Plant depreciation		600
Materials handling	2	12
Supervisors' salaries	3	60
Other overheads	4	72

Notes

1. Electricity costs are split equally between heating and lighting (50%) and power for production machines (50%).
2. Materials requisitions during the year are expected to average 20 per day for Dept. M, 15 per day for Dept. A, and 2 per day for each of Departments F and R.
3. There are two supervisors who cover the whole of the production and service operations of the country. It is estimated that a production employee requires three times the supervision of a service employee.
4. Other overheads are incurred 90% on production and 10% on servicing. The individual production and service departments are treated as equally responsible for their share of such costs.

The following information is relevant to the company and its departments:

	Departments				
	M	A	F	R	D
Floor space (sq.m.)	100,000	71,000	25,000	3,000	1,000
No. of employees	15	8	5	2	2
Plant value (£000s)	2,200	500	250	40	10
Budgeted machine hours	56,000	6,000	500		

The budgeted production details for the coming year are expected to be as follows:

	X	Y	Z
Direct materials per unit (£)	£3.70	£6.40	£8.90
Direct labour per unit (hours):			
Dept. M (paid at £5.00 per hour)	0.4	0.6	0.7
Dept. A (paid at £4.50 per hour)	0.3	0.3	0.3
Dept. F (paid at £4.25 per hour)	0.1	0.2	0.3
Moulding machine time per unit (hours)	0.8	1.0	1.4
Expected output (units)	10,000	20,000	20,000

(a) Given that Dept. M is machine-intensive and Departments A and F are labour-intensive, calculate the total absorption cost per unit for each of the company's three products using the most reasonable overhead absorption rates.

(b) The managing director has heard that using overhead absorption rates based on estimated figures can result in the under- or over-recovery of overheads. Write a brief memorandum to the managing director explaining the advantages of using estimated OARs, the situations in which under- or over-recovery of overheads may occur and the accounting treatment of such items.

2. A friend of yours is about to set up in business manufacturing and selling virtual reality jogging machines that will give users the perception that they are jogging through the countryside. The following information relates to the costs of producing 3500 jogging machines per year:

Although these figures are based on the production of 3500 machines, production capacity is 4000 machines per annum. The budgeted selling price is £280 per machine.

	£
Material costs	260,000
Labour costs	320,000
Production overhead	160,000
Selling and distribution overhead	150,000
Administration overhead	60,000

Following discussion with your friend, you ascertain that £207,000 of labour costs, 100% of administration overhead, 30% of production overhead and 50% of selling and distribution overhead are fixed in nature. All other costs are variable with the level of production.

(a) Calculate the unit contribution of a jogging machine and the total contribution of the budgeted level of production and sales.
(b) Calculate the amount of profit at the budgeted level of production.
(c) Construct a break-even chart, clearly showing the break-even point in units, the margin of safety and the budgeted level of production.

3. Ontario PLC manufactures three products, X, Y and Z. The following table includes information relating to the manufacture of each product

Product	Budgeted output	Material cost per unit £	Direct labour per unit (hours)	Machine time per unit (hours)	Labour cost per unit £
X	6000	15	0.25	0.25	2
Y	8500	24	0.4	0.25	2
Z	4800	18	0.4	0.50	4

The draft production overhead budget for next year contains the following departmental budgets:

Machine-oriented overheads	£16,500
Set-up costs	£38,920
Material ordering	£24,630
Material handling	£32,480

The budget absorbs these overheads into production using a budgeted machine hour rate of £18.68 per hour. This is budgeted to produce overhead costs per product as follows: X = £4.67, Y = £4.67, Z = £9.34. However, it has been proposed that the overhead budget be recalculated using activity-based costing. The following information has been provided for this purpose:

Product	Number of set-ups	Number of material orders	Number of times material is handled
X	1	1	3
Y	4	3	10
Z	2	2	3

(a) Recalculate the production overhead budget per product using activity-based costing, tracing costs to products by cost drivers.
(b) Discuss the assertion that activity-based costing is likely to produce a fairer unit product cost than total absorption costing.

4. The Dreamwheel Cycle Company is considering manufacturing a new bicycle and has prepared the following estimates of cost and selling price:

	£
Unit labour cost	20.00
Unit material cost	15.00
Unit packaging cost	5.00
Proposed selling price	80.00
Budgeted fixed cost per period	
0–7000 units	150,000
7001 units and above	320,000

Fixed overheads have been estimated by the company and represent both the apportionment of the company's existing fixed overheads to the new bicycle and the additional fixed costs incurred in the event of manufacture. Expansion beyond 7000 units will require the rental of additional premises and further additional fixed costs as shown above. Maximum production and sales are estimated at 9,000 units.

(a) Prepare a break-even chart for the bicycle identifying clearly the break-even points, and identify the profits (or losses) that would be made with sales of 6000 units and 8500 units.
(b) Comment on the results shown by the chart and interpret the key points shown by the chart for management together with any limitations in your analysis.

5. An airline catering company produces three standard meal packs about which the following information is available for next year:

Pack	Expected output (numbers of packs)	Production staff time per pack (minutes)	Total material costs £
X	90,000	10	247,500
Y	70,000	12	250,000
Z	40,000	15	180,000

For next year the production staff budget is £187,200 with a pay rate of £4.80 per hour.
Apart from production staff and material costs, overheads are estimated at £1,010,000 and are made up as follows:

	Notes	£000
Ordering materials		300
Production run set ups		110
Quality control	1	90
Packing & dispatch of orders		60
Negotiation with customers		200
Central management costs	2	250
Total		1010

Notes:

1. The quality control costs are related to testing a random sample of orders dispatched.
2. The central management costs are not attributed to any activities and are to be absorbed on the basis of production staff hours.

In the coming year, the activity volumes are expected to be as follows:

	X	Y	Z
Set-ups	35	35	30
Orders for materials	85	110	105
Orders dispatched to customers	160	200	140

In the current year and in previous years the company has absorbed overheads with productive staff hours as the absorption base. Prices have been based upon full cost plus 20%. In recent years prices have been steady using this approach. The costs and prices for the current year are as follows:

Product	Full Cost	Price (Full cost + 20%)
X	£7.80	£9.36
Y	£9.50	£11.40
Z	£12.10	£14.52

(a) Determine the full cost of each pack for next year using:

 (i) an absorption approach with direct production staff hours as the absorption base.

 (ii) an activity-based approach using the information given above.

(b) Comment on the results of your calculations and indicate the advantages and disadvantages of moving to an activity-based approach.