Chapter 8

Process costing

Real world case 8.1

This case study shows a typical situation in which management accounting can be helpful. Read the case study now but only attempt the discussion points after you have finished studying the chapter.

Sugar beet processing

British Sugar, part of Associated British Foods, provides sugar for the top brand names in sugar confectionery, chocolate confectionery, soft drinks and preserves, etc. The company has six factories in the UK, with each one split between a 'beet end' and a 'sugar end'. Typically, a factory processes beet between September and March, termed the 'Campaign'. The 'beet end' employs various processes to create 'thick juice', a liquid which has 65 per cent sugar content. The 'sugar end' boils the 'thick juice' and seeds it with tiny sugar crystals, providing the nucleus for larger crystals to form and grow to create sugar. The business of processing beet gives rise to several challenges which directly affect process efficiency, sugar yields from the beet, and ultimately factory profitability.

Source: *Process and Control*, March 2003 'Maximising sugar beet processing', p. 22 www.connectingindustry.com.

Discussion points

1 Why is a specific kind of costing needed for a process of this kind?

2 Why might the quantity of material output be less than the quantity input?

Contents

8.1 Introduction 183

8.2 Allocation of costs to products in a process industry 184
- 8.2.1 Process costing where there is no opening work-in-progress 185
- 8.2.2 Process costing where there is work-in-progress at the start of the period 187
- 8.2.3 Separate material and conversion costs 189

8.3 Joint product costs and by-products 192
- 8.3.1 Joint costs allocated on the basis of physical measures 192
- 8.3.2 Joint costs allocated by relative sales value at the point of separation 193
- 8.3.3 Further processing costs 193
- 8.3.4 Treatment of by-products 194
- 8.3.5 Relevance of allocating joint costs 195

8.4 Decisions on joint products: sell or process further 196

8.5 What the researchers have found 197
- 8.5.1 Process costs, standard costs and ABC 197
- 8.5.2 Joint costs 198

8.6 Summary 198

Learning outcomes

After reading this chapter you should be able to:

- Explain how process costing differs from job costing.
- Carry out calculations to allocate costs to products in a process industry.
- Explain and calculate joint product costs and by-product costs.
- Explain how decisions are made about joint products based on cost information.
- Describe and discuss examples of research into process costing and joint product costs.

8.1 Introduction

Special **process costing** techniques are required where there is a continuous flow of production of similar units of output. This situation of a continuous process arises in the chemical industry and in other industries such as textiles, paint, food, steel, glass, mining, cement and oil.

As an example of a company where processes are important, Exhibit 8.1 contains an extract from the annual report of a chemicals company describing the group's products. The products of this company which derive from these chemical processes are many and varied. Viscose rayon, the first cellulose fibre, is a chemical name most readily related to womenswear and furnishing fabrics, but it is also found in clutch linings, insulating material within railway signalling cables and tea bags. The rayon process is also used to make film for sweet wrappings, baked goods and soft cheeses. In the area of coatings, the company produces marine paint which keeps the hulls of ships and yachts free of barnacles. Another type of paint for the superstructure of ships transforms rust stains into colourless deposits. Other products involving a flow process include the manufacture of specialist film which makes glass shatter-resistant, toothpaste tubes and rigid packaging products such as special housings for asthma inhalers.

Exhibit 8.1
The products of a chemicals company

> We are a chemical materials company. Our products are made by chemical processes. But with a few exceptions they are not themselves pure chemicals: they are products made from chemicals. These products are based on two related technical disciplines. The first of these is polymer technology linked with surface science – used to coat, seal or protect a diverse range of surfaces. The second is fibre technology, with particular emphasis on cellulose chemistry.

This is the type of business where individual products are indistinguishable in nature and there are no special needs of customers in relation to individual items of product. What is of interest to management is the cost and performance of the continuous process as a whole.

Definition

> **Process costing** is appropriate to a business or operation where there is a continuous flow of a relatively high volume of similar products during a reporting period.

Management's purposes in a continuous process business are no different from those in any other organisation. There is an overall requirement on the part of management for decision making and judgement. In this context, accounting information is required for management purposes of planning, decision making and control.

Management accounting contributes by:

- directing attention
- keeping the score
- solving problems.

In particular, management accounting must be able to show, in relation to a flow process, how much cost has flowed through with the product into finished goods and how much remains with the work-in-progress. That is part of the score-keeping aspect of management accounting. If the process splits, taking different directions for different output, the management accountant will be expected to contribute information relevant to decision making about the various products. That is an example of the problem-solving aspects of management accounting.

This description of the management accountant's role is not substantially different from a description which could apply in any job-costing situation; however, there are some specific problems in the process industries which require specially designed management accounting techniques. This chapter deals with two of these problems, as follows:

1 Individual products cannot be distinguished for costing purposes. Costs cannot be assigned directly to products but must be allocated (spread) using some averaging basis.
2 Joint products and by-products are produced as an unavoidable result of the process of creating the main products. Total costs must therefore be shared across main products and by-products. Joint products each have a significant sales value. By-products usually have relatively low sales value.

8.2 Allocation of costs to products in a process industry

In process costing, items in production flow from one process to the next until they are completed. Each process contributes to the total operation and then passes its output to the next process until the goods are finished and can be stored to await sale. Recording of costs follows the physical flow as closely as possible. Because it is not possible to identify each unit of output on its way through the various processes, the concept of an **equivalent unit** is applied. Each completed item is equivalent to one unit of output, but each incomplete item is equivalent to only a fraction of a unit of output. This concept is particularly important at the end of the reporting period for dealing with items in process which are incomplete.

Definition

An **equivalent unit of output** is the amount of output, expressed in terms of whole units, which is equivalent to the actual amount of partly or fully completed production.

Process costing requires several stages of analysis of the costs. These are:

(a) collect the data for the period;
(b) prepare a statement of physical flows and equivalent units of output for the period;
(c) ascertain the total costs to be accounted for this period;
(d) calculate the cost per equivalent unit;
(e) apportion the cost between finished output and work-in-progress; and
(f) check that all costs are accounted for.

Collecting data requires information on the quantities of materials, labour and other resources put into the process and the quantities of products emerging from the process in any period of time. Because of the continuous nature of any process, it is likely that some products will be partly completed at the beginning and end of the period. Such partly completed work is referred to as *work-in-progress*. Information is also required on the costs of the period, separated into material, labour and production overheads. Sometimes the labour and overhead costs are referred to collectively as *conversion costs* because they convert the input materials into products.

Physical flows into and out of the process have to be identified. There will be *opening work-in-progress* at the beginning of the period which is completed during the period. Some products will be started and finished in the period. Some will be started but will be incomplete at the end and will be described as *closing work-in-progress*.

Materials may be introduced at the beginning of the period, while further materials may be introduced part-way through the period.

Identifying the total costs to be accounted for requires some care. There will be costs incurred during the period, but there will also be costs brought forward from the previous period, included in the opening work-in-progress. All these costs must be shared between the products completed during the period and the work-in-progress remaining at the end of the period.

The *cost per equivalent unit* is a particular feature of process costing which takes into account the problem of partly completed units at the beginning and end of the period. If an item is 40 per cent completed, then it represents the equivalent of 40 per cent (or 0.4 as a fraction) of one completed unit. So if there are 3,000 units held, each of which is 40 per cent complete, they can be said to represent the equivalent of 1,200 completed units and would be described as 1,200 equivalent units.

Apportioning costs between finished output and work-in-progress is relatively straightforward. Once the cost per equivalent unit has been calculated, it is multiplied by the number of equivalent units of finished items to give the cost of finished output and by the number of equivalent units of closing work-in-progress to give the cost of closing work-in-progress.

Finally, it is essential to check that nothing has been gained or lost in the arithmetic process by comparing the total costs of input to the process with the total costs of output in the period. If the totals are the same, then the worst problem that can have occurred is a misallocation between finished goods and work-in-progress. If the totals are not the same, a careful search for errors is required.

These steps in the process-costing approach are conveniently illustrated and explained by working through an example and commenting on the main features of interest.

8.2.1 Process costing where there is no opening work-in-progress

Process costing can be a complicated exercise. However, to learn the approach it is best to start with a simplified example and work up to the various complications one at a time. Exhibit 8.2 illustrates process costing for the first month of a reporting period where there is no work-in-progress at the start of the month but there is some by the end. Five steps are shown, corresponding to the first five stages of the process described earlier in this section.

Exhibit 8.2
Process costing illustration: No opening work-in-progress

Step 1 Collect data for the period

The following information relates to the assembly department in a company manufacturing shower units for bathrooms. A pack of materials is introduced at the start of the process. The pack contains a plastic shower head, flexible hose and various plumbing items. These are assembled by employees and then passed from the assembly department to the electrical department for connection to the electric power unit. At the end of the month there will be some shower units only partly completed. The supervisor of the assembly department has estimated that these units are 40 per cent completed at that date.

Data in respect of month 1
No work-in-progress at start of month.
60,000 units of raw materials introduced for conversion.
40,000 units of output completed during the month.
20,000 units of work-in-progress, 40 per cent completed at end of month.
Costs incurred on material, labour and overheads: £120,000.

Exhibit 8.2 continued

Step 2 Prepare a statement of physical flows and equivalent units of output for the month

The physical flow involves 60,000 units entering the process for assembly. Of these, 40,000 are fully assembled and 20,000 partly assembled at the end of the period. This physical flow is shown in the left-hand column as a check that all items are kept under control. For accounting purposes the concept of an equivalent unit, as explained earlier, is more important. So the final column contains the equivalent units. For the goods which are finished during the month, the equivalent units are 100 per cent of the physical units. For the goods which are still in progress, the equivalent units of 8,000 are calculated as 40 per cent of the physical amount of 20,000 units of work-in-progress.

	Physical flow (units)	*Equivalent units of output*
Input:		
Materials introduced	60,000	
	60,000	
Output:		
Goods finished this month	40,000	40,000
Work-in-progress at end (40 per cent completed)	20,000	8,000
Total equivalent units	60,000	48,000

Step 3 Ascertain total costs to be accounted for this period

As there is no work-in-progress at the beginning of the period, the only costs to be accounted for are the costs of £120,000 incurred during the period.

	£
Opening work-in-progress	none
Incurred this month	120,000
Total to account for	120,000

Step 4 Calculate cost per equivalent unit

Continuing the emphasis on equivalent units (rather than physical units), a unit cost is calculated by dividing the costs of the period, £120,000 as shown in step 3, by the number of equivalent units, 48,000, as shown in step 2. The benefit of having a cost per equivalent unit is that it gives a fair allocation to completed and partly completed units, as shown in step 5.

$$\text{Cost per equivalent unit} = \frac{\pounds 120{,}000}{\pounds 48{,}000} = \pounds 2.50$$

Step 5 Apportion cost between finished output and work-in-progress

The cost per equivalent unit, which is £2.50, is now applied to the finished output and to the work-in-progress, measuring the quantity of each in equivalent units.

	£
Value of finished output 40,000 × £2.50	100,000
Work-in-progress 8,000 × £2.50	20,000
Total costs accounted for	120,000

Fiona McTaggart has the following comment.

FIONA: *From step 5 of Exhibit 8.2 you will see that the total costs accounted for are the same as the costs in step 3 which required allocation. It is always important to check back to the starting data to make sure that nothing has been lost or created inadvertently in the calculation process. There could still be an error within the allocations if the wrong approach has been taken, so a separate check of all calculations is generally useful.*

It is also good practice to explain in words what each calculation is intended to achieve. If you cannot explain it in words, that is an indication that you do not fully understand the calculation and neither will anyone else reading your work. If you can explain with confidence, then it is more likely that you are correct or, if you are incorrect, that the cause of any error will be seen readily by another person.

Activity 8.1

Starting again with the data of Exhibit 8.2, close the book and check that you are able to produce the process cost information ending with the value of finished output and the value of work-in-progress. You must understand and be confident about Exhibit 8.2 before you read further.

8.2.2 Process costing where there is work-in-progress at the start of the period

The first complication to be introduced is the presence of work-in-progress at the start of the period. Opening work-in-progress introduces a complication because it carries costs from the end of one period to the beginning of the next. The problem faced by the management accountant is to decide between two possible courses of action. The first is to take those costs as being added to (*accumulated*) with the costs incurred in the current period and spread over all equivalent units of output. The second is to regard them as remaining firmly attached to the partly completed products with which they arrived. The first of these possibilities is called the *weighted average method* and the second is called the *first-in-first-out method*. It will be sufficient for the purposes of this textbook to illustrate the weighted average method, which is the more commonly used in practice.

Exhibit 8.3 takes on to month 2 the story which began in Exhibit 8.2. Work-in-progress is carried from the end of month 1 to the start of month 2. The weighted average method follows the same five steps as were used in Exhibit 8.2. The cost figure calculated at step 3 is the total of the costs brought forward with the opening work-in-progress and the costs incurred in the month. At step 4 the cost per equivalent unit is calculated by dividing all costs by total equivalent output.

Here is Fiona McTaggart to comment.

FIONA: *This method is called the weighted average approach because it averages all costs over all equivalent output and ignores the fact that some of the production started in the previous period.*

I usually like the weighted average method because it is not too fiddly and allows me to divide all costs of the period by the equivalent units of output without having to worry about what started where. However, some of my clients do not like this approach because, they say, it is mixing some of last month's costs with other costs incurred this month. Instead of spreading all costs over all production, their suggestion is to allocate this month's cost to the items started and finished in the month and to allow opening work-in-progress to carry the costs with which it arrived.

My answer is that it's a good idea, but more time-consuming. I also mention, tactfully, that the approach has already been thought of and is called the first-in-first-out method of process costing. It requires more work by the accountant but generally gives results that are only marginally different from the weighted average method.

Exhibit 8.3
Process costing illustration: opening work-in-progress

Step 1 Collect data for the period

Step 1 starts by bringing forward the work-in-progress of month 1. If you look back to step 1 of Exhibit 8.2 you will see that the closing work-in-progress was 20,000 units, each 40 per cent complete. To this is added 30,000 shower head packs for assembly. We are then told that 35,000 units are completed and 15,000 are one-third completed at the end of month 2.

Data in respect of month 2
20,000 units work-in-progress at start, 40 per cent complete.
30,000 units of raw materials introduced for conversion.
35,000 units of output completed during the month.
15,000 units of work-in-progress, one-third completed at end of month.

Costs incurred on material, labour and overheads: £120,000.

Step 2 Prepare a statement of physical flows and equivalent units of output for the month

In step 2 the left-hand column is used to keep track of the physical flow of units and the right-hand column shows the equivalent units of output for month 2. For the finished goods the equivalent units are 100 per cent of the finished physical units but for the work-in-progress the equivalent units are one-third of the physical units, as specified in step 1.

	Physical flow (units)	*Equivalent units of output*
Input:		
Work-in-progress at start	20,000	
Material introduced	30,000	
	50,000	
Output:		
Goods finished this month	35,000	35,000
Work-in-progress at end (33.3 per cent completed)	15,000	5,000
Total equivalent units	50,000	40,000

Step 3 Ascertain total costs to be accounted for during this period

There are two separate elements of cost which together must be allocated to the total equivalent units of output for the period. The first element is the value of work-in-progress at the start of the period. This is a portion of the costs incurred in the first month that has been brought forward to the second month in order to match it with the units completed during the period. The second element is the new cost incurred during the second month.

	£
Opening work-in-progress brought forward	20,000
Incurred this month	120,000
Total to account for	140,000

Step 4 Calculate cost per equivalent unit

Continuing the emphasis on equivalent units, the cost of £140,000 calculated in step 3 is divided by the total number of equivalent units calculated as 40,000 in step 2. The result is a cost of £3.50 per equivalent unit, calculated as follows:

$$\text{Cost per equivalent unit} = \frac{£140{,}000}{40{,}000} = £3.50$$

Exhibit 8.3 continued

Step 5 Apportion cost between finished output and work-in-progress

The cost of £3.50 per equivalent unit is applied to the equivalent units of finished output and to the equivalent units of work-in-progress. This gives a fair allocation of the total cost of £140,000 between the finished and unfinished goods as follows:

	£
Value of finished output 35,000 × £3.50	122,500
Work-in-progress 5,000 × £3.50	17,500
Total costs accounted for	140,000

Activity 8.2

Pause here to test your confidence of Exhibit 8.3. Take a note of the data provided at the start of the example, close the book and write out the steps of the process cost calculations. Write down a brief explanation of each step which you could give to a fellow student who has not read this chapter but would like an idea of what it contains.

8.2.3 Separate material and conversion costs

The illustrations provided so far have assumed that all materials are introduced at the start of the process. In practice, materials may be added at intervals during the process, so that conversion work can be carried out in stages.

Exhibit 8.4 shows the separate analysis of materials and conversion costs. It relates to a company which introduces materials into the process in two batches, so that work-in-progress might have all its materials added or might contain only half of the total, depending on the stage of production reached at any particular month-end. The conversion work is continuous throughout the month.

Exhibit 8.4
Separate materials and conversion costs

Step 1 Collect data for the period

The business assembles plant propagation boxes. At the start of the process a set of plastic components is introduced, assembled and coated with a weather-proof protective coating. The glass plates are then added and a decorative finish given to the assembled unit. Because there are two points at which materials are introduced (plastic components and then glass plates), some items may be only 50 per cent complete in respect of materials at the end of the reporting period.

Data in respect of the month of April
4,000 units work-in-progress at start, 100 per cent complete in respect of materials, 25 per cent complete in respect of conversion.
6,000 units of raw materials introduced for conversion.
8,000 units of output completed during the month.
2,000 units of work-in-progress, 50 per cent complete in respect of materials, 10 per cent complete in respect of conversion.

Cost of opening work-in-progress, £60,000, consisting of £30,000 for materials and £30,000 for conversion costs.
Costs incurred in the month on materials are £150,000 and on conversion costs £216,000.

Exhibit 8.4 continued

Step 2 Prepare a statement of physical flows and equivalent units of output for the month

As in Exhibits 8.2 and 8.3, the physical flow is recorded in the left-hand column. However, there are now two columns to the right of this, each showing one component of the equivalent units of output. Using two columns allows different percentages to be applied to work-in-progress for materials and conversion costs as follows:

	Physical flow (units)	Equivalent units of output			
			Material		Conversion
Input:					
Work-in-progress at start	4,000				
Material introduced	6,000				
	10,000				
Output:					
Goods finished this month	8,000		8,000		8,000
Work-in-progress at end	2,000	50%	1,000	10%	200
Total equivalent units	10,000		9,000		8,200

Step 3 Identify total costs to be accounted for this period

In step 1 there is information about costs brought forward and costs incurred in the month. In each case the costs of the components of materials and conversion are shown separately. This separate classification allows the calculation of a separate unit cost for each component. The total costs to be accounted for under each heading are as follows:

	Material	Conversion	Total
	£	£	£
Opening work-in-progress brought forward	30,000	30,000	60,000
Incurred this month	150,000	216,000	366,000
Total costs to be accounted for	180,000	246,000	426,000

Step 4 Calculate cost per equivalent unit

Two costs per equivalent unit can now be calculated, one relating to materials and one to conversion. The total costs from step 3 are divided by the equivalent units from step 2. Materials have been used in 9,000 equivalent units of output but conversion costs have been applied to only 8,200 equivalent units of output. The calculations are as follows:

	Material	Conversion
Total costs to be accounted for	£180,000	£246,000
Number of equivalent units	9,000	8,200
Cost per equivalent unit	£20	£30

The total cost of an item of completed output is therefore £50 per equivalent unit. Work-in-progress at the end of the period is calculated in two separate components, using the figures of £20 per equivalent unit of materials and £30 per equivalent unit of conversion work.

Step 5 Apportion cost between finished output and work-in-progress

The unit costs calculated in step 4 may now be applied to the finished goods and work-in-progress. The finished goods are 100 per cent complete in respect of materials and conversion costs, so it saves calculation time to use the total unit cost of £50 and multiply it by the 8,000 finished units.

For work-in-progress some care is needed. For the materials component, the work-in-progress is equivalent to 1,000 units, but for conversion costs it is equivalent to only

Exhibit 8.4 **continued**

200 units, as shown in step 2. Separate calculations are shown in the table below for each component. The total costs accounted for are £426,000 which is equal to the total costs shown in step 3 above.

	£	£
Value of finished output 8,000 × £50		400,000
Work-in-progress:		
Materials 1,000 × £20	20,000	
Labour 200 × £30	6,000	
		26,000
Total costs accounted for		426,000

Activity 8.3

Go back to the start of Exhibit 8.4. Take a note of the data provided and then close the book. Write out all the steps of cost allocation for the process and make sure that you understand each stage. Imagine that you are a manager instructing an employee who will prepare the monthly process cost statements. How would you explain the steps of cost allocation in such a way that the employee could produce reliable data? How would you check the work of such an employee?

Real world case 8.2

Reducing heat production costs

The main markets for New Zealand's forest industry are either dry or treated timber. In both cases heat energy is required. This heat demand comprises the larger part of the energy requirements of a sawmill.

Process heat can be produced through either fossil fuels or bioenergy. Burning wood waste to produce heat is a common way of saving costs on sawmilling sites. Almost half of the wood in a sawmilling process ends up as some form of wood waste or is used for some other process. In a large number of New Zealand mills, this wood waste is burned to produce heat for drying kilns and timber treatment plants. This fuel is 'free' in the sense that it is collected on site, but there are still costs associated with handling the wood waste, storing the wood waste and capital investment. Mills that don't use wood waste will be using some form of fossil fuel in their heating plants, and the rising costs of fossil fuels will be impacting on the cost of manufacturing dry and treated timber.

Source: http://www.bkc.co.nz/Whocanbenefit/Sawmiller/Reducingprocesscosts/tabid/72/Default.aspx.

Discussion points

1 Why is the wood waste fuel not a 'free' resource?

2 How could the business estimate the cost saving in recycling wood waste as a fuel?

8.3 Joint product costs and by-products

A manufacturing process may result in more than one product. If the second item is produced as an unavoidable result of producing the first, but has a significant sales value in comparison with the first, then it is called a **joint product**. If the second item is produced as an unavoidable result of producing the first, but is of negligible sales value, then it is called a **by-product**. In the case of joint products, it is desirable to know the separate cost of each item. Product costs may be required for valuing stocks and work-in-progress, calculating product profitability, setting selling prices which cover costs and deciding whether to vary the mix of products.

The accounting treatment of a by-product is somewhat different. Any proceeds of sale of the by-product are used to offset the cost of the main product, which includes the cost of manufacturing the by-product. In the case of by-products it is not necessary to have a valuation for stock purposes because the item is relatively insignificant. It is more important for management purposes to know that the proceeds of sale of the by-product reduce the effective cost of the main product.

Definitions

Joint products are two or more products arising from a process, each of which has a significant sales value.

A **by-product** is a product arising from a process where the sales value is insignificant by comparison with that of the main product or products.

This section looks firstly at joint costs and then at by-products. There are several methods of allocating cost to joint products, two of which will be explored here. These are: by physical measures and by relative sales value. The example contained in Exhibit 8.5 will be used to compare both approaches.

Exhibit 8.5
Data for use in allocation of joint costs

A chemical process requires input of materials costing £900 per batch. From each batch there are two products, being 1,000 litres of perfume oil base which sells for £2 per litre and 500 litres of oil for artists' paint which sells at £1 per litre.

8.3.1 Joint costs allocated on the basis of physical measures

As stated in Exhibit 8.5, the proportions of physical measures are 1,000:500, which reduces to 2:1. Allocating the joint costs of £900 on the basis 2:1 gives £600 as the cost of perfume oil and £300 as the cost of artists' paint oil.

A statement of product profit is shown in Table 8.1. The calculation of profit on each product is based on subtracting the allocated joint costs from the separate sales figures. In the final line of the exhibit the profit as a percentage of sales is shown.

This is not a particularly good method of allocating costs because it shows one product as being much more profitable, in relation to sales, than the other. That profitability is very much dependent on the allocation method used for the joint costs. Taken out of context, such an allocation might lead the managers of the business into an over-hasty decision to raise the price of the perfume oil base. It would, however, be a mistake to base such a decision on an allocation of costs that could change when a different method is used. Now look at what happens when the joint costs are allocated by reference to the sales value at the point of separation.

Table 8.1
Statement of product profit for joint products: physical measures

	Perfume oil base	*Oil for artists' paint*
	£	£
Sales	2,000	500
Joint costs allocated	600	300
Profit	1,400	200
Profit as % of sales	70%	40%

8.3.2 Joint costs allocated by relative sales value at the point of separation

A method which is generally thought to be an improvement on allocation by physical measures is that of allocating the joint cost of £900 in relation to the sales value at the point of separation. The sales value proportions are 2,000:500 so that the allocation is as follows:

		£
Perfume oil base	2,000/2,500 × £900	720
Oil for artists' paint	500/2,500 × £900	180
		900

A statement of product profit, based on this allocation, would appear as in Table 8.2.

Table 8.2
Statement of product profit for joint products: relative sales value

	Perfume oil base	*Oil for artists' paint*
	£	£
Sales	2,000	500
Joint costs allocated	720	180
Profit	1,280	320
Profit as % of sales	64%	64%

This approach leads to a profit which is 64 per cent of sales for each product. Allocating joint costs in proportion to sales value means that the performance measure, taken as the profit margin on sales, is not distorted by the cost allocation process. The calculation would leave the managers of a business satisfied that they had no problems with either product and would avoid bringing on an ill-considered decision to cease production of one product item.

8.3.3 Further processing costs

Now consider a variation on the previous story. Suppose there are further costs incurred after the separation of the joint products. The information used earlier is now amended somewhat in Exhibit 8.6, to introduce and illustrate this variation. The amendments are shown in bold print.

Exhibit 8.6
Joint cost allocation where there are further processing costs

A chemical process requires input of materials costing £900 per batch. From each batch there are two products, being 1,000 litres of perfume oil base which sells for £2 per litre and 500 litres of oil for artists' paint which sells at £1 per litre. **After the two products have been separated, further processing costs are incurred, amounting to £600 per batch in the case of perfume oil base and £100 per batch in the case of oil for artists' paint.**

The recommended approach in this situation is to calculate a notional sales value at the point of separation. That is not as fearsome as it sounds. It requires taking the final sales price of the item and deducting the processing costs incurred after separation. That leaves the notional sales value at the point of separation. Calculations are shown in Table 8.3, and from these calculations it may be seen that the profit as a percentage of sales is no longer the same for each product. That is to be expected, however, because the costs after separation have a relatively different impact on each product.

Table 8.3
Cost allocation based on notional sales value at the point of separation

(a) Calculation of notional sales value at the point of separation

	£	£
Selling price per batch	2,000	500
Costs incurred after separation	600	100
Notional selling price before separation	1,400	400

(b) Allocation of joint cost based on notional selling price before separation

		£
Perfume oil base	1,400/1,800 × £900	700
Oil for artists' paint	400/1,800 × £900	200
		900

(c) Calculation of profit for each joint product

	Perfume oil base		*Oil for artists' paint*	
	£	£	£	£
Sales		2,000		500
Joint costs allocated	700		200	
Costs after separation	600		100	
		1,300		300
Profit		700		200
Profit as % of sales		35		40

8.3.4 Treatment of by-products

By-products are items of output from a process which have a relatively minor sales value compared with that of the main product.

The accounting treatment of by-products is similar to the accounting treatment of scrap. The proceeds of sale are offset against the cost of the main product. An example of a process which leads to a by-product is set out in Exhibit 8.7.

The calculation of the cost of the main product, perfume oil base, and the resulting profit is shown in Table 8.4. The joint cost of £900 is reduced by the sales proceeds from the by-product, which are £50. The net cost of £850 becomes the cost of sales of the perfume oil, which is the main product. There would be no useful purpose in allocating cost to the by-product and then calculating a separate figure of profit, because the amounts are insignificant.

Exhibit 8.7
Process which creates a by-product

A chemical process requires input of materials costing £900 per batch. From each batch there are two products, being 1,000 litres of perfume oil base which sells for £2 per litre and 500 litres of waste oil which sells at 10 pence per litre.

Table 8.4
Joint cost allocation and profit calculation

	£	£
Sales of perfume oil base, per batch		2,000
Joint costs	900	
Less: sales proceeds of waste oil by-product	(50)	
Net cost per batch		850
Profit per batch		1,150

8.3.5 Relevance of allocating joint costs

Is the allocation of joint costs useful? In this chapter we have shown that this type of cost allocation is an exercise where there is a variety of possible outcomes. Sometimes this variety of outcomes is described as an *arbitrary allocation process* because it depends so much on the choice made by the individual manager.

Throughout this management accounting text there is an emphasis on the management purposes of planning, decision making and control. If the purpose of the joint cost exercise is to allocate all costs in the fairest possible manner for purposes of planning and control, then using notional sales value at the point of separation will give a fair allocation in many circumstances. The allocation of full cost may be required for purposes of stock valuation or it may be required for control purposes to make senior managers aware that ultimately they have a responsibility for all costs.

If, however, a decision has to be made, such as processing further or changing a selling price, then that decision must be based on **relevant costs** rather than on a full allocation of joint costs.

Definition

Relevant costs are those future costs which will be affected by a decision to be taken. Non-relevant costs will not be affected by the decision. The decision-making process therefore requires careful attention to those costs which are relevant to the decision.

This chapter concludes by setting out a decision where joint costs are present, but the allocation of those costs is not relevant to the decision.

Activity 8.4

Explain to a production manager the joint cost problems raised by the following description of a process producing glass bottles.

A typical mixture might be sand 60 per cent; limestone 8 per cent; soda ash 18 per cent; mineral additives 5 per cent. Up to 25 per cent of the mix can comprise cullet (recycled glass). From one mixture the molten glass would be run off into moulds for narrow bottles (such as wine bottles) and wide-mouth containers (such as jam jars). Bottles which have flaws or chips are broken up and recycled.

Real world case 8.3

Clorox is the global leader in the production of bleach. Clorox also makes laundry and cleaning items (Formula 409, Pine-Sol, Tilex), cat litter (Fresh Step), car-care products (Armor All, STP), the Brita water-filtration system (in North America), and charcoal briquettes (Kingsford). Its First Brands buy gave Clorox Glad-brand plastic wraps, storage bags, and containers.

Process Cost Evaluation – Clorox's approach to cost management is grounded on an in-depth understanding of its key processes and the resources consumed by these processes. Clorox conducts an exhaustive analysis to map its 25 key processes and, based on historical activity-based costing information, it assesses a gold-standard cost for each process. The company continuously evaluates the resources consumed by each process against this gold standard to uncover potential inefficiencies.

The company's process orientation is based on the belief that a total-value-chain view rather than a (traditional/redundant) isolated-activity view is key to understanding inefficiencies. The company tries to understand the interrelationships between each step in a process and between processes to identify unnecessary redundancy and complexity

Source: http://www.executiveboard.com/2009guidance/pdf/Clorox_Process_Cost_Evaluation.pdf.

Discussion points

1 What are the aspects of the bleach manufacturing industry that make process costing useful?

2 Why is process costing particularly suitable for this company?

8.4 Decisions on joint products: sell or process further

Where there are joint products there may be a decision required at the point where they separate. The decision usually involves the prospect of incurring further costs with the hope of improving revenue thereby. Is it worthwhile to incur the extra cost of adding perfume? The decision should be based on **incremental costs** and **incremental revenues**, as illustrated in the example shown in Exhibit 8.8, which is analysed in Table 8.5.

Definition

Incremental costs are the additional costs that arise from an activity of the organisation. To justify incurring incremental costs it is necessary to show they are exceeded by **incremental revenue.**

Exhibit 8.8
Situation requiring a decision

In a company manufacturing personal care products, a process requires the input of ingredients costing £400 per batch. Separation of the output from each batch yields 200 litres of hand cream which sells at a price of £1.60 per litre and 200 litres of soap solution which sells at a price of 80 pence per litre. The soap solution in that form is suitable for industrial use, but at a further cost of £50 per batch of 200 litres it could be perfumed and sold for domestic use at £1.20 per litre.

Activity 8.5

Write down, with reasons, the action you would recommend for the situation described in Exhibit 8.8. Then read the commentary by Fiona McTaggart and check your answer against Table 8.5. Did you arrive at the same answer? If not, what was the cause of the difference?

Fiona McTaggart has given some thought to this problem.

FIONA: *The decision question contained in Exhibit 8.8 is, 'Do we make soap for industrial use or do we make it suitable for domestic use?' What is not in question is the production of hand cream and the production of soap solution. This means that the information about hand cream is not relevant to the decision and neither is the information about the costs of ingredients. I have rewritten the information in Exhibit 8.8 and highlighted the information relevant to this decision problem, as follows:*

In a company manufacturing personal care products, a process requires the input of ingredients costing £400 per batch. Separation of the output from each batch yields 200 litres of hand cream which sells at a price of £1.60 per litre and **200 litres of soap solution which sells at a price of 80 pence per litre**. The soap solution in that form is suitable for industrial use, but at a further cost of **£50 per batch of 200 litres it could be perfumed and sold for domestic use at £1.20 per litre**.

My calculation of the incremental revenue and costs is shown in Table 8.5. It shows that there is an extra profit of £30 per batch if the soap solution is perfumed for domestic use. So the decision should be to go ahead.

In relation to the decision, allocation of the joint cost of £400 is *not* relevant because it is a cost which is incurred regardless of whether the perfume is added. In a similar vein, pricing decisions should have regard to the need to cover total costs but should not be based on arbitrary allocations of costs across products.

Table 8.5
Statement of incremental costs and revenues

		£
Incremental revenue	200 litres × (£1.20 – 0.80)	80
Incremental cost		50
Incremental profit per batch		30

8.5 What the researchers have found

8.5.1 Process costs, standard costs and ABC

Sharman and Vikas (2004) are enthusiastic supporters of German cost accounting. Sharman, in particular, is concerned that there has been too much emphasis in the US on financial reporting and auditing. He sees management accounting as a part of the processes inside an organisation that help to create good governance. Their paper includes a description of process-based costing as applied by Deutsche Telekom. This process-based costing is described as 'a more disciplined form of activity based costing' where standard costs are linked to ABC in providing cost information about the processes in a terrestrial telephone system. Understanding the business process is an essential condition of designing a useful and relevant costing analysis.

The paper is interesting for its description of the system used by Deutsche Telekom, but it also illustrates how a major company can design its own management accounting by taking aspects of a range of textbook models. In this case it links ABC and standard costs to produce a company-wide costing of the processes of the business.

8.5.2 Joint costs

Trenchard and Dixon (2003) explain a real-life joint cost problem found in the not-for-profit manufacture of blood products in the UK. There is a legal requirement for cost-based transfer pricing. However, the cost of the blood products is not clear. Transfusion services provide a joint platelet product and a more costly, but better quality, non-joint alternative. For accounting convenience, all the joint costs are allocated to red cells and none to platelets. So the platelets have a zero cost at the point of splitting them off from the red blood cells. The paper is a research note in which the authors describe the problem, rather than solving it. They suggest that one method of allocating the joint costs would be to relate these to a measure of the relative 'usefulness' of each product. Then they discuss the ways of measuring usefulness in a clinical sense. This proposal to evaluate usefulness gives a not-for-profit alternative to the sales-based method normally suggested for allocating joint costs.

8.6 Summary

Key themes in this chapter are:

- **Process costing** is a technique which can be applied to a business or operation where there is a continuous flow of a relatively high volume of similar products during a reporting period. It is a contrast to job costing (see Chapter 6) where separate jobs or products may be identified for cost allocation and apportionment.
- In a process some units are complete but others are part-complete. The idea of an **equivalent unit** of output allows whole units and part units to be added so that costs can be shared across them.
- The weighted average approach averages all costs over all the equivalent output of the period and ignores the fact that some of the production started in the previous period.
- **Joint products** arise when a manufacturing process leads to two or more products, each having a significant sales value.
- A **by-product** is a product arising from a process where the sales value is insignificant by comparison with that of the main product or products.
- When a decision is required on whether to process joint products further rather than sell them at the point of separation, **relevant costs** must be compared. The relevant costs are the **incremental costs**, which are justified if they produce a higher **incremental revenue**.

References and further reading

Sharman, P. and Vikas, K. (2004) 'Lessons from German cost accounting', *Strategic Finance*, December: 28–35.

Trenchard, P.M. and Dixon, R. (2003) 'The clinical allocation of joint blood product costs: research note', *Management Accounting Research*, 14: 165–76.

QUESTIONS

The Questions section of each chapter has three types of question. '**Test your understanding**' questions to help you review your reading are in the 'A' series of questions. You will find the answer to these by reading and thinking about the material in the textbook. '**Application**' questions to test your ability to apply technical skills are in the 'B' series of questions. Questions requiring you to show skills in '**Problem solving and evaluation**' are in the 'C' series of questions. A symbol [S] means that there is a solution available at the end of the book.

A Test your understanding

A8.1 Which industries might need to use the techniques of process costing (section 8.1)?

A8.2 What is meant by the term *equivalent unit* (section 8.2)?

A8.3 What are the steps to follow in calculating the cost of finished goods and the value of closing work-in-progress in respect of a reporting period (section 8.2.1)?

A8.4 Where there is work-in-progress at the start of any reporting period, how is this accounted for using the weighted average approach (section 8.2.2)?

A8.5 Why may it be necessary to account for materials and conversion costs separately (section 8.2.3)?

A8.6 What is the difference between a joint product and a by-product (section 8.3)?

A8.7 How may joint costs be allocated to joint products using a basis of physical measures (section 8.3.1)?

A8.8 How may joint costs be allocated to joint products using a basis of relative sales value (section 8.3.2)?

A8.9 How is relative sales value at the point of separation determined when there are further processing costs of each joint product after the separation point (section 8.3.3)?

A8.10 What is the accounting treatment of cash collected from the sale of a by-product (section 8.3.4)?

A8.11 Why should care be taken when using process costing information for decision making in respect of joint products (section 8.4)?

A8.12 Why is it necessary to use incremental revenues and costs in making a decision on whether to sell or to process further in the case of joint products (section 8.4)?

A8.13 What have researchers found about the potential for linking process costs, standard costs and activity-based costs (section 8.5.1)?

A8.14 What have researchers found about the impact of joint cost problems in a not-for-profit situation (section 8.5.2)?

A8.15 [S] Work-in-progress at the end of the month amounts to 2,000 physical units. They are all 40% complete. What are the equivalent units of production? The cost of production is £3 per equivalent unit. What is the value of work-in-progress?

A8.16 [S] In process X there are 12,000 units completely finished during the month and 3,000 units of work-in-progress. The work-in-progress is 60% complete for materials and 20 per cent complete for conversion costs (labour and overhead). What are the equivalent units of production for the work-in-progress?

A8.17 [S] XYZ Ltd processes and purifies a basic chemical which is then broken down by reaction to give three separate products. Explain the approaches to joint cost allocation using the following information:

Product	*Units produced*	*Final market value per unit* (£)	*Costs beyond split-off point* (£)
A	3,000	5.00	4,000
B	1,000	4.00	1,800
C	2,000	3.00	2,400

Joint costs incurred up to the split-off point are £2,000.

B Application

B8.1 [S]

In a continuous flow process, the following information was collected in relation to production during the month of May:

	Units
Work-in-progress at start of month (60% complete)	50,000
New units introduced for processing	80,000
Completed units transferred to store	100,000
Work-in-progress at end of month (20% complete)	30,000

Opening work-in-progress was valued at cost of £42,000. Costs incurred during the month were £140,000.

Required

Calculate the value of finished output and work-in-progress using the weighted average method.

B8.2 [S]

Clay Products Ltd produces handmade decorative vases. A process costing system is used. All materials are introduced at the start of the process. Labour costs are incurred uniformly throughout the production process.

The following information is available for the month of July:

Work-in-progress at 1 July (60% complete)	2,000 units
Work-in-progress at 31 July (30% complete)	1,200 units

The value of work-in-progress at 1 July is as follows:

	£
Direct materials cost	1,700
Direct labour costs	1,900
	3,600

During the month of July, 7,000 vases were transferred to finished goods stock. Materials introduced cost £14,700. Labour costs incurred were £12,820.

Required

Using the method of weighted averages, prepare a process cost statement for the month of July showing unit costs, the value of finished goods and the value of work-in-progress at the end of the month.

B8.3 [S]

Refinery Ltd buys crude oil which is refined, producing liquefied gas, oil and grease. The cost of crude oil refined in the past year was £105,000 and the refining department incurred processing costs of £45,000. The output and sales for the three products during that year were as follows:

Product	*Units of output*	*Sales value* £	*Additional processing costs* £
Liquefied gas	10,000	20,000	12,000
Refined oil	500,000	230,000	60,000
Grease	5,000	8,000	–

The company could have sold the products at the split-off point directly to other processors at a unit selling price of 50p, 35p and £1.60 respectively.

Required

(1) Compute the net profit earned for each product using two suitable methods of joint cost allocation.
(2) Determine whether it would have been more or less profitable for the company to have sold certain products at split-off without further processing.

B8.4 [S] [CIMA question]

A company manufactures paint from two sequential processes (P1 and P2). Details for P1 for a period were as follows:

Input materials	20,000 litres costing £114,000
Conversion costs	£176,000
Opening work in progress	nil
Transferred to P2	15,000 litres
Normal loss	5% of input
Abnormal loss	500 litres
Closing work in progress	3,500 litres (complete in respect of materials, 60% converted)

The company uses the weighted average method of process costing. All losses occur at the end of the process.

Prepare the P1 Process Account for the period.

CIMA Paper P1 – Management Accounting – Performance Evaluation November 2008, Question 1.13

B8.5 [S] [CIMA question]

Under examination conditions this question would be allocated approximately 18 minutes.

NLM uses a common process to manufacture three joint products: X, Y and Z. The costs of operating the common process total $75,400 each month. This includes $6,800 of apportioned head office costs. The remaining costs are specific to the common process and would be avoided if it were discontinued. Common costs are apportioned to the joint products on the basis of their respective output volumes.

The normal monthly output from the common process is:

X 4,000 litres
Y 5,000 litres
Z 4,500 litres

There are a number of manufacturers of products that are identical to products X, Y and Z and as a result there is a competitive market in which these products can be bought and sold at the following prices:

X $5.00 per litre
Y $4.50 per litre
Z $5.50 per litre

Currently NLM uses the output from the common process as input to three separate processes where X, Y and Z are converted into SX, SY and SZ. The specific costs of these further processes (which are avoidable if the further process is discontinued) are as follows:

X to SX $1.25 per litre plus $1,850 per month
Y to SY $1.80 per litre plus $800 per month
Z to SZ $1.55 per litre plus $2,400 per month

The market selling prices of the further processed products are:

SX $6.75 per litre
SY $7.50 per litre
SZ $7.20 per litre

Required:

(a) Advise NLM as to which (if any) of the further processes should continue to be operated. State any relevant assumptions.

(6 marks)

(b) Advise NLM whether they should continue to operate the common process. State any relevant assumptions.

(4 marks)
(Total for Question = 10 marks)

CIMA Paper P2 – Management Accounting – Decision Management November 2008, Question Two

C Problem solving and evaluation

C8.1 [S]
A product is manufactured in a continuous process carried on successively in two departments, Assembly and Finishing. In the production process, materials are added to the product in each department without increasing the number of units produced.

For July Year 2 the production records contain the following information for each department:

	Assembly	*Finishing*
Units in process at 1 July	0	0
Units commenced in Assembly	80,000	–
Units completed and transferred out	60,000	50,000
Units in process at 31 July	20,000	10,000
Cost of materials (£)	240,000	88,500
Cost of labour (£)	140,000	141,500
Cost of production overhead (£)	65,000	56,600
Percentage completion of units in process:		
Materials	100%	100%
Labour and overhead	50%	70%

Required
Determine the cost per equivalent unit for each department.

C8.2
Chemicals Ltd owns a supply of North Sea gas liquids, and is developing its downstream activities. It is producing two main products, propane and butane, and there is a by-product, arcone. There are four manufacturing processes involved where the gas passes through Modules 1, 2, 3 and 4.

Production information for April Year 2 is as follows:

1,000 tonnes of liquid A and 600 tonnes of liquid B were issued to Module 1.

Liquid C is issued to Module 2 at the rate of 1 tonne per 4 tonnes of production from Module 1.

Liquid D is added to Module 4 at the rate of 1 tonne per 3 tonnes of output from Module 2.

Arcone arises in Module 1 and represents 25% of the good output of that process. The remaining output of Module 1 passes to Module 2. Of the Module 2 output 75% passes to Module 3 and 25% passes to Module 4. The output of Module 3 is propane and the output of Module 4 is butane.

Materials costs are:

	£
Liquid A	60 per tonne
Liquid B	40 per tonne
Liquid C	75 per tonne
Liquid D	120 per tonne

The labour and overhead costs during the month were:

	£
Module 1	22,400
Module 2	38,750
Module 3	12,000
Module 4	10,000

The company is considering selling the products at the undernoted prices:

	£
Propane	130 per tonne
Butane	150 per tonne
Arcone	100 per tonne

Required

(1) Draw a diagram of the various processes described.

(2) Ascertain the percentage profit on selling price per tonne of each of these products.

Case studies

Real world cases

Prepare short answers to Case studies **8.1**, **8.2** and **8.3**.

Case 8.4 (group case study)

You are the management team of a tree-growing business. Your team consists of the financial adviser, the plant grower and the sales representative. The business has been growing small hedging conifers from seedlings to three years of age and then selling the plants through mail order in bundles of 25 small bare-rooted plants. A garden centre has offered to buy plants in pots for sale in its retail outlets provided the plants are between five and six years old and are symmetrical in shape. If the plants are grown to five years of age, they will be too old to be sold as bare-rooted plants, but could be sold for use as shelter belts in parkland or country estates.

Your team has arranged a meeting to discuss the cost implications of the alternative courses of action. Each person should come to the meeting with a list of costs and benefits. The purpose of the meeting is to set out a list of factors to be investigated further for precise costing. Take five minutes for individual preparation, 10 minutes for a group discussion and then give feedback from your meeting to the rest of the class.

Case 8.5 (group case study)

Divide your group into two teams. One team is the business advisory service of the local enterprise council which offers start-up funding for new ventures. The other team is a group of textile science researchers from the local university. The scientists have developed a new form of medical dressing for burns. The dressing is produced by a continuous flow process and can be cut to lengths specified by the customer. The main customers are hospitals. The health trusts which operate the hospitals will pay a price based on cost plus a percentage for profit. The scientists do not know how to work out the cost in a continuous flow process.

For five minutes the team acting as the business advisers should prepare a short list of key rules in process costing. At the same time, the team acting as the scientists should prepare a list of key questions to ask about process costing. Both teams should then meet and discuss their prepared lists and questions (10 minutes). Finally, one person should report to the rest of the class on the problems of explaining and understanding process costing.