

19. Process: Cost systems

Learning objectives

After studying this chapter, you should be able to:

- Describe the types of operations that require a process cost system.
- Distinguish between process and job costing systems.
- Discuss the concept of equivalent units in a process cost system.
- Compute equivalent units of production and unit costs under the average cost procedure.
- Prepare a production cost report for a process cost system and discuss its relationship to the Work in Process Inventory account.
- Distinguish between normal and abnormal spoilage.
- Compute equivalent units of production and unit costs under the first-in first-out (FIFO) system (Appendix 19-A).
- Discuss how joint costs are allocated to joint products (Appendix 19-B).

This chapter continues the discussion of cost accumulation systems. In Chapter 18, we explained and illustrated job costing. The **job cost system (job costing)** accumulates costs incurred to produce a product according to individual jobs. For example, construction companies use job costing to keep track of the costs of each construction job.

This chapter discusses another cost accumulation system, process costing. The chapter begins with a discussion of the nature of a process cost system. We review the similarities and differences between job costing and process costing. We also present an extended illustration of process costing that includes a discussion of equivalent units of production and the production cost report. In the chapter appendixes, we discuss and illustrate FIFO process costing and the allocation of joint product costs.

Nature of a process cost system

Many businesses produce large quantities of a single product or similar products. Pepsi-Cola makes soft drinks, Exxon Mobil produces oil, and Kellogg Company produces breakfast cereals on a continuous basis over long periods. For these kinds of products, companies do not have separate jobs. Instead, production is an ongoing process.

A **process cost system (process costing)** accumulates costs incurred to produce a product according to the processes or departments a product goes through on its way to completion. Companies making paint, gasoline, steel, rubber, plastic, and similar products using process costing. In these types of operations, accountants must accumulate costs for each process or department involved in making the product. Accountants compute the cost per unit by first accumulating costs for the entire period (usually a month) for each process or department. Second,

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they divide the accumulated costs by the number of units produced (tons, pounds, gallons, or feet) in that process or department.

In "A broader perspective: Producing cans of Coca-Cola", we describe production in bottling and canning plants that use a process cost system. Job costing and process costing have important similarities:

- Both job and process cost systems have the same goal: to determine the cost of products.
- Both job and process cost systems have the same cost flows. Accountants record production in separate accounts for materials inventory, labor, and overhead. Then, they transfer the costs to a Work in Process Inventory account.
- Both job and process cost systems use predetermined overhead rates (defined in Chapter 18) to apply overhead.

Job costing and process costing systems also have their significant differences:

- Types of products produced. Companies that use job costing work on many different jobs with different production requirements during each period. Companies that use process costing produce a single product, either on a continuous basis or for long periods. All the products that the company produces under process costing are the same.
- Cost accumulation procedures. Job costing accumulates costs by individual jobs. Process costing accumulates costs by process or department.
- Work in Process Inventory accounts. Job cost systems have one Work in Process Inventory account for each job. Process cost systems have a Work in Process Inventory account for each department or process.

Exhibit 1 shows the cost flows in a process cost system that processes the products in a specified sequential order. That is, the production and processing of products begin in Department A. From Department A, products go to Department B. Department B inputs direct materials and further processes the products. Then Department B transfers the products to Finished Goods Inventory. For illustration purposes, we assume that all the process cost systems in this chapter are sequential. There are many production flow combinations; Exhibit 2 presents three possible production flow combinations.

Process costing illustration

Assume that Jax Company manufactures and sells a chemical product used to clean kitchen counters and sinks. The company processes the product in two departments. Department A crushes powders and blends the basic materials. Department B packages the product and transfers it to finished goods. Exhibit 2 shows this manufacturing process.

The June production and cost data for Jax Company are:

	Department A	Department B
Beginning inventory	-0-	-0-
Units started, completed, and transferred	11,000	9,000
Units on hand June 30, partially completed	-0-	2,000
Direct materials	\$16,500	\$1,100
Direct labor	2,500	2,880
Actual overhead	7,500	8,600
Applied overhead	7,400	8,880

Illustration 19.1 Cost Flows in a Process Cost System

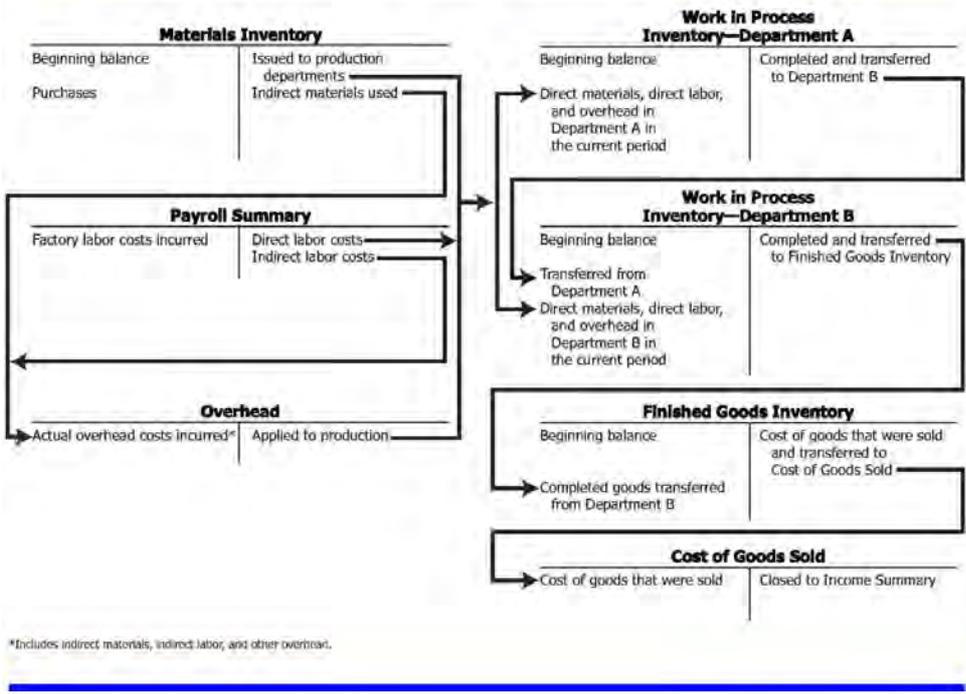


Exhibit 1: Cost flows in a process cost system

(Jax's accountant applies manufacturing overhead in Departments A and B based on the machine-hours used in production.) From these data, we can construct and summarize the Work in Process Inventory—Department A account below.

Work in process inventory – Department A		
Direct materials	16,500	Transferred to department B: 11,000 units @ \$2.40
Direct labor	2,500	
Applied overhead	7,400	
Balance	-0-	

Department A completed all the units it started in June and transferred them to Department B. So all the costs assigned to these units were transferred to Department B. Jax's accountant computed the unit costs in Department A by dividing the USD 26,400 total costs by the 11,000 units completed and transferred. The result is USD 2.40, the average unit cost of 11,000 units.

Computations are seldom this simple; one complication is partially completed inventories. Consider Department B, for example. Before Department B transfers the cost of completed units, its Work in Process Inventory account for June is as follows:

Work in process inventory – Department B	
Transferred in from department A	26,400
Costs added in Dept. B:	
Direct materials	1,100
Direct labor	2,880
Applied overhead	8,880
Balance	39,260

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Illustration 19.2 Possible Production Flow Combinations

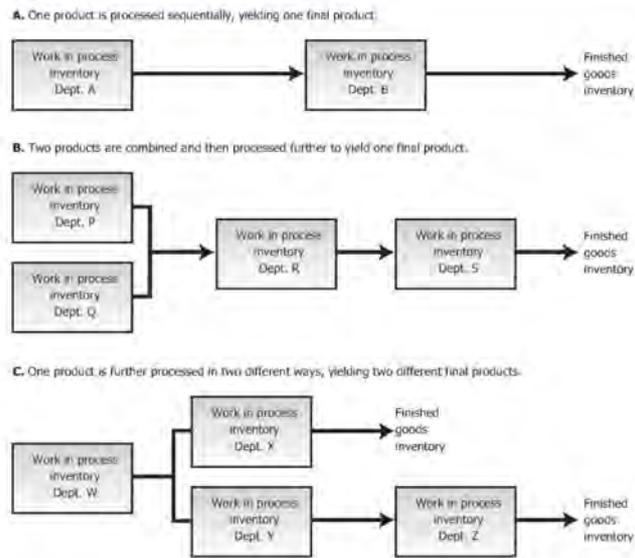


Illustration 19.3 Product Flows in a Process Cost System (Jax Company example)

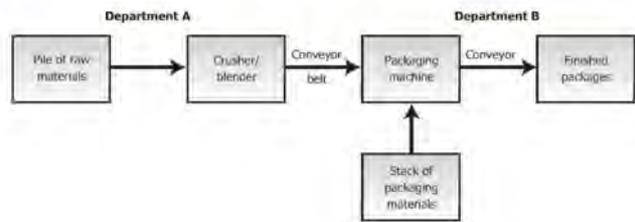


Exhibit 2: Possible production flow combinations

A broader perspective:

Producing cans of Coca-Cola®

How was the Diet Coke® I just finished drinking produced? A Coca-Cola bottling plant purchased cola syrup or a concentrate from The Coca-Cola Company, combined it with carbonated water, put it in cans, and sealed the cans. (Although these plants are usually called bottling plants, they also produce cans of Coke®.)

In a bottling plant, the first process combines the syrup or concentrate with carbonated water to make cola. In a second process, empty cans are rinsed and inspected. A third process combines these two materials by pouring the cola into the cans. Next, tops are placed on the cans. Finally, the cans are combined into packages. This completes the work in process stage.

The product enters finished goods inventory when it is sent to the warehouse. The product becomes cost of goods sold to the bottling plants when it is shipped to distributors or retail outlets.

Source: Based on the authors' research and documents provided by The Coca-Cola Company. Coca-Cola, Diet Coke, and Coke are registered trademarks of The Coca-Cola Company.

Recall that direct materials, direct labor, and applied overhead are product costs; that is, the costs attach to the product. Thus, Transferred in from Department A in the T-account represents the direct materials, direct labor, and applied overhead costs assigned to products in Department A. These costs have followed the physical units to Department B.

Now, Jax's accountant must divide the USD 39,260 total costs charged to Department B in June between the units transferred out and those remaining on hand in the department. The accountant cannot divide USD 39,260 by 11,000 units to get an average unit cost because the 11,000 units are not alike. Department B has 9,000 finished units and has 2,000 partially finished units. To solve this problem, the accountant uses the concept of equivalent units of production, which we discuss next.

Essentially, the concept of **equivalent units** involves expressing a given number of partially completed units as a smaller number of fully completed units. For example, if we bring 1,000 units to a 40 per cent state of completion, this is equivalent to 400 units that are 100 per cent complete. Accountants base this concept on the supposition that a company must incur approximately the same amount of costs to bring 1,000 units to a 40 per cent level of completion as it would to complete 400 units.

On the next page look at Exhibit 3, a diagram of the concept of equivalent units. As you examine the diagram, think of the amount of water in the glasses as costs that the company has already incurred.

The beginning step in computing Department B's equivalent units for Jax Company is determining the stage of completion of the 2,000 unfinished units. These units are 100 per cent complete as to **transferred-in costs**; if they were not, Department A would not have transferred them to Department B. In Department B, however, the units may be in different stages of completion regarding the materials, labor, and overhead costs. Assume that Department B adds all materials at the beginning of the production process. Then both ending inventory and units transferred out would be 100 per cent complete as to materials. Therefore, equivalent production for materials would be 11,000 units.

Accountants often assume that units are at the same stage of completion for both labor and overhead. Accountants call the combined labor and overhead costs conversion costs. **Conversion costs** are those costs incurred to convert raw materials into the final product.

Let us assume that, on average, the 2,000 units in ending inventory are 40 per cent complete as to conversion costs. This means that Department B transferred out 9,000 units fully completed and brought 2,000 units to a 40 per cent completion state. Department B now has an equivalent of 800 fully completed units remaining in inventory ($800 = 2,000 \times 40$ per cent). The equivalent units for labor and overhead would therefore be 9,800 units.

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Illustration 19.4 The Concept of Equivalent Units

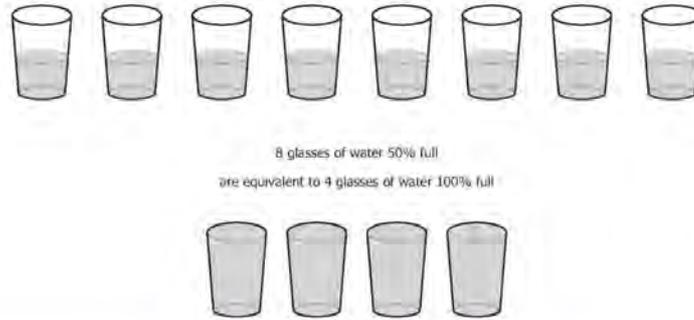


Exhibit 3: The concept of equivalent units

The formula for equivalent units for each cost element (transferred-in, materials, and conversion) is:

$$\text{Equivalent units} = \text{Units completed} + (\text{Units in ending inventory} \times \text{per cent complete})$$

When we know the equivalent units of production, we can compute unit costs for transferred-in, materials, and conversion elements. The average unit cost formulas for each cost element are:

$$\text{Unit cost for transferred} = \frac{\text{Total transferred costs}}{\text{Equivalent units for transferred costs}}$$

$$\text{Unit cost for materials} = \frac{\text{Total materials costs}}{\text{Equivalent units for conversion costs}}$$

$$\text{Unit cost for conversion} = \frac{\text{Total conversion costs}}{\text{Equivalent units for conversion costs}}$$

Now we can compute unit costs for each element in Department B as follows:

	Transferred-in	Materials	Conversion	Total
Costs to be accounted for:				
Charged to Department B	\$26,000	\$1,100	\$11,760*	\$39,260
Equivalent units	11,000	11,000	9,800†	
Unit costs	\$ 2.40	\$ 0.10	\$ 1.20	\$ 4.70

*Conversion costs consist of direct labor + overhead (\$2,880 + \$8,880).

†Units transferred out (9,000) + equivalent units in ending inventory (800).

We can use the USD 3.70 computed unit costs to divide Department B's USD 39,260 June costs between the units completed and transferred out and the units remaining in the department's ending inventory. We do this in the following table:

	Transferred-in (@ \$2.40)	Materials (@ \$0.10)	Conversion (@ \$1.20)	Total
Costs accounted for:				
Units completed and transferred out (9,000 units)	\$21,600	\$900	\$10,800	\$33,300
Units remaining in ending inventory (2,000 units)	4,800	200	960*	5,960
Costs accounted for	\$26,400	\$1,100	\$11,760	\$39,260

*Equivalent units = 800 units

The USD 33,300 total costs transferred out of Department B consist of USD 21,600 transferred in from Department A (9,000 X USD 2.40), USD 900 of materials costs (9,000 X USD 0.10), and USD 10,800 of conversion costs (9,000 X USD 1.20), or a total cost of USD 3.70 per unit. The 2,000 units of ending inventory in Department B are fully complete as to costs transferred in from Department A and materials and 40 per cent complete as to conversion. We calculate the ending inventory cost as follows:

Costs from Department A (2,000 x \$2.40)		\$4,500
Costs added by Department B:		
Materials (2,000 x \$0.10)	\$200	
Conversion (800 equivalent units x \$1.20)	960	1160
Total cost of ending inventory		\$5,960

Jax carries units transferred out of Department B in finished goods inventory at a cost of USD 3.70 each until they are sold. Then, Jax charges the cost of units sold to Cost of Goods Sold.

An ethical perspective: Rynco Scientific Corporation

Rynco Scientific Corporation was a manufacturer of contact lenses that the Securities and Exchange Commission (SEC) investigated concerning the way it computed equivalent units of production. According to the SEC, Rynco made errors in calculating the equivalent units of production that materially overstated its ending inventory, and understated its losses. As a result of the SEC's investigation, Rynco agreed to hire an accounting firm to conduct a thorough study of its financial statements for a five-year period, and it agreed to restate its financial statements to conform to generally accepted accounting principles.

We have discussed how to determine the costs of each cost element placed in production, transferred to finished goods inventory, and charged to cost of goods sold. Now let us look at the summary of the journal entries for these activities for the month of June.

1.	Work in process inventory – Department A (+A)	16,500	
	Work in process inventory – Department B (+A)	1,100	
	Materials inventory (-A)		17,600
	To record materials placed in production in June.		
2.	Work in process inventory – Department A (+A)	2,500	
	Work in process inventory – Department B (+A)	2,880	
	Payroll summary (+L)		5,380
	To assign labor costs to departments.		
3.	Work in process inventory – Department A (+A)	7,400	
	Work in process inventory – Department B (+A)	8,880	
	Overhead (or manufacturing overhead) (+SE)		16,280
	To apply overhead to production.		
4.	Work in process inventory – Department B (+A)	26,400	
	Work in process inventory – Department A (-A)		26,400
	To record transfer of goods from Department A to Department B.		
5.	Overhead (of Manufacturing Overhead) (-SE)	16,100	
	Various accounts – Cash, Accounts payable, accruals, and accumulated depreciation (varies)		16,100
	To record actual overhead costs incurred in June.		
6.	Finished goods inventory (+A)	33,300	
	Work in process inventory – Department B (-A)		33,300

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To record transfer of completed goods from Department B to finished goods.

If Jax Company sold 6,000 of these completed units in June at USD 10 per unit on account, it would make the following entries:

7. Accounts receivable (+A)	60,000	
Sales (+SE)		60,000
To record sales on account.		
8. Cost of goods sold (-SE)	22,200	
Finished goods inventory (-A)		22,200
To record cost of goods sold in June, 6,000 units @ \$3.70.		

The key document in a process costing system is the production cost report. A **production cost report** shows both the flow of units and the flow of costs through a processing center. It also shows how accountants divide these costs between the cost of units completed and transferred out and the cost of units still in the processing center's ending inventory. This report makes the equivalent unit and unit cost computations easier.

To illustrate the preparation of a production cost report with partially completed beginning and ending inventories, assume the following June 2011 data for Department 3 of a different company, Storey Company:

Units	
Units in beginning inventory, complete as to materials, 60% complete as to conversion costs	6,000
Units transferred in from Department 2	18,000
Units completed and transferred out	16,000
Units in ending inventory, completed as to materials, 50% complete as to conversion costs	8,000

Costs		
Cost of beginning inventory:		
Costs transferred in from Department 2 in May	\$12,000	
Materials added in May in Department 3	6,000	
Conversion costs (labor and overhead)	3,000	\$21,000
Costs transferred in from Department 2 in June		37,200
Costs added in Department 3 in June:		
Materials	\$18,480	
Conversion (equal amounts of labor and overhead)	18,000	36,480
Total costs in beginning inventory and placed in production in Department 3 in June		\$94,680

The preparation of the production cost report includes the following four steps:

- Trace the physical flow of the units through the production department.
- Convert actual units to equivalent units.
- Compute unit costs for each cost element.
- Distribute the total cost between the units completed and transferred out and the units remaining in the ending inventory.

Using the June data, Storey developed the production cost report for Department 3 shown in Exhibit 5.

The first step in the preparation of a production cost report is to trace the physical flow of actual units in and out of Department 3. The units section in Exhibit 5 shows that Department 3 had 6,000 units in the June beginning inventory. Department 3 also had 18,000 units transferred in from Department 2. This makes a total of 24,000 units for which Department 3 must account.

Of these 24,000 units, Department 3 completed and transferred out 16,000 units (either to the next processing department or to finished goods). At the end of the month, Department 3 had 8,000 partially completed units. These 8,000 units are the June ending inventory. Now we are ready for the second step in the preparation of the production cost report—to convert actual units to equivalent units.

Storey Company's cost of production report uses the average cost procedure. Under the **average cost procedure**, the number of equivalent units for each cost element equals the number of units transferred out plus the number of equivalent units of that cost element in the ending inventory. The average cost procedure does not consider the number of units in the beginning inventory and the degree of completion of the beginning inventory. Alternatively, Storey could use First-in, First-out (FIFO) or Last-in, First-out (LIFO). We use the average cost procedure in this chapter because it is simpler and commonly used in practice.

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Storey Company Production Cost Report - For the month of June 2011					
Units	Actual units	Department 3 Transferred- in	Equivalent units Materials	Conversion	
Units in beginning inventory	6,000				
Units transferred in from Department 2	18,000				
Units to be accounted for	24,000				
Units completed and transferred out	16,000	16,000	16,000	16,000	
Units in ending inventory*	8,000	8,000	8,000	4,000	
Units accounted for	24,000	24,000	24,000	20,000	
Costs		Transferred- in	Materials	Conversion	Total
Costs to be accounted for:					
Costs in beginning inventory		\$12,000	\$6,000	\$3,000	\$21,000
Costs transferred in from Department 2 in June		37,200			37,200
Costs added in Department 3			18,480	18,000	36,480
Costs to be accounted for		\$49,200	\$24,480	\$21,000	\$94,680
Equivalent units (from above)	24,000	24,000	24,000	20,000	
Unit cost (per equivalent unit)†		\$2.05	\$1.02	\$1.05	\$4.12
Costs accounted for:					
Units completed and transferred out (16,000 units)		\$32,800	\$16,320	\$16,800	\$65,920
Units remaining in ending inventory (8,000 units)*		16,400	8,160	4,200	28,760
Costs accounted for		\$49,200	\$24,480	\$21,000	\$94,680

*Inventory is complete as to materials added, 50% complete as to conversion.

† Unit cost equals costs to be accounted to divided for divided by equivalent units.

Exhibit 4: Production cost report

Storey's units in the ending inventory are fully complete as to costs transferred in and materials cost. Therefore, the number of equivalent units for each of these cost elements is 24,000 (16,000 units completed and transferred out + [8,000 units in the ending inventory X 100 per cent complete for transferred-in costs and materials costs]). The 8,000 units remaining in ending inventory are 50 per cent complete as to conversion. Therefore, there are 20,000 equivalent units with regards to conversion—16,000 units transferred out plus 8,000 units in ending inventory that were 50 per cent complete.

Once a company has computed its equivalent units, it must calculate the unit costs. This is the third step in preparing the production cost report. Each cost element of production—costs transferred in, materials, and conversion—has accumulated costs. Notice in Exhibit 4 that for each cost element, we total the costs of beginning inventory and costs of the current month. We refer to the total costs charged to a department as costs to be accounted for. These costs must either be transferred out or appear in the ending inventory of Department 3.

To determine the cost per equivalent unit for each cost element, divide the total cost for each cost element by the equivalent units of production related to that cost element. (Since we totaled all costs for each cost element before the division, we can average the computed unit costs across the current and prior period.) Exhibit 4 shows the average per unit costs for June as transferred-in costs, USD 2.05; materials costs, USD 1.02; and conversion costs, USD 1.05. In monitoring these costs closely for cost control purposes, management watches for extreme fluctuations from one month to the next.

The last step in preparing the production cost report is to allocate costs between the units completed and transferred out and the units remaining in ending inventory. The units transferred out were fully complete as to all elements of production. Therefore, we can multiply the 16,000 units by USD 4.12, the total cost per unit. The result, USD 65,920, is the amount Storey assigns to the next department as cost transferred in or to finished goods as the cost of completed current period production. We now compute the cost of ending inventory as follows:

8,000 equivalent units transferred in @ \$2.05
8,000 equivalent units of materials costs @ \$1.02
4,000 equivalent units of conversion costs @ \$1.05
Total cost of ending inventory

The sum of the ending inventory cost and the cost of the units transferred out must equal the total costs to be accounted for. This built-in check determines whether the company has properly followed the procedures of cost allocation. As shown in the production cost report, Department 3 adds the USD 65,920 costs transferred out to the USD 28,760 ending inventory cost. The total equals the USD 94,680 for which Department 3 must account.

Some companies replace the production cost report with three schedules. The first schedule is the schedule of equivalent production. This schedule computes the equivalent units of production for the period for transferred-in, materials, and conversion costs. The second schedule is the unit cost analysis schedule. This schedule sums all the costs charged to the Work in Process Inventory account of each production process department. Then it calculates the cost per equivalent unit for transferred-in, materials, and conversion costs. The third schedule is the cost summary schedule. This schedule uses the results of the preceding two schedules to distribute the total costs accumulated during the period among all the units of output. Companies generally show these three schedules in a process cost analysis report.

Companies that use a process cost system may use the **first-in, first-out (FIFO) method** instead of the average cost procedure. Generally, under FIFO, the equivalent number of units for each cost element consists of:

- Work needed to complete the units in beginning inventory.
- Work done on units started and completed during the period.
- Work done on partially completed units in ending inventory.

Appendix 19-A, at the end of this chapter, illustrates this method.

Now that you have studied both job costing in Chapter 18 and process costing in this chapter, you can appreciate why manufacturing companies must accurately account for product unit costs. Without accurate cost accounting information, a manufacturing company cannot determine the cost of its products for managerial decision making or prepare accurate financial statements.

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Process costing in service organizations

Service organizations that provide similar services to a variety of customers are potential users of process costing. For example, a clinic dispensing flu shots, a delicatessen selling only pastrami sandwiches, and a photo shop that processes pictures could use process costing. In manufacturing, the difficult task is to match period costs with the units produced that period, which is why companies compute equivalent units of production. (And that is what most people find difficult about process costing.)

Generally, service companies complete the service by the end of the period and have no work in process at the end of the period. Nurses do not leave for home halfway through giving a flu shot, and the delicatessen does not partially serve a sandwich one month and complete it the next. Consequently, there is no need to compute equivalent units, which simplifies process costing.

Note that some service companies do have partially completed work at the end of the period. Certain types of dry cleaning and photo processing may still be in process at the end of a period. You could apply the methods described in this chapter for manufacturing to those service companies. For materials, you could substitute any significant supplies, and for conversion costs, service labor and overhead.

Spoilage

If you have ever tried to make something that did not work out, you know the concept of spoilage. **Spoilage** refers to the loss of goods during production. For example, suppose some of the cans are dented during the canning of tuna fish. Accountants would treat the cost of the dented cans of tuna fish as spoilage.

Accountants treat spoilage either as normal spoilage or abnormal spoilage. **Normal spoilage** occurs in the normal production process. Accountants generally assign normal spoilage costs to the good units produced. According to one method found in practice, accountants divide the total cost of production by the good units produced.

For example, suppose the total cost of producing tuna fish for one day is USD 100,000. The company produced 220,000 cans of tuna fish, but 20,000 cans of tuna fish did not meet quality inspection requirements. Consequently, these 20,000 units were considered to be spoiled in the normal production process. One way accountants deal with the cost of such normal spoilage is to compute the cost per good unit by dividing total production costs by the number of good cans of tuna fish produced. That is:

$$\text{Cost per good unit} = \frac{\text{USD } 100,000}{200,000 \text{ good units produced}}$$

$$= \text{USD } 0.50 \text{ per good unit produced}$$

Abnormal spoilage refers to spoilage that exceeds the amount expected under normal operating conditions. For example, if denting the tuna fish cans is unusual, accountants would treat the cost of those dented cans of tuna fish as abnormal spoilage. Whereas normal spoilage costs are assigned to good products, abnormal spoilage costs are typically expensed. Thus, accountants treat normal spoilage as a product cost and abnormal spoilage as a period cost.

Advocates of total quality management may prefer to classify all spoilage as abnormal. Normal spoilage costs are buried in the costs of the good products. Unless management personnel ask for a special analysis of spoilage costs,

they will not know whether the spoilage costs are a small per cent or a large per cent of product costs. For example, management could see a report on tuna fish production costs stating the cost is USD 0.50 per can, but they do not know how much of the USD 0.50 was the cost of spoilage.

We recommend that accountants report spoilage costs to management, whether normal spoilage or abnormal spoilage, so management can make informed decisions to reduce spoilage.

Understanding the learning objectives

- Process cost systems are used for businesses that produce products on a continuous basis over long periods.
- Paint, paper, chemicals, gasoline, beverages, and food products should be accounted for under a process cost system.
- Types of products produced under each system: Companies that use job costing work on many different jobs with different production requirements during each period. Companies that use process costing produce a single product, either on a continuous basis or for long periods.
- Cost accumulation procedures used under each system: Job costing accumulates costs by individual jobs. Process costing accumulates costs by process or department.
- Work in Process accounts: Job cost systems have a Work in Process Inventory account for each job. Process cost systems have a Work in Process Inventory account for each department or process.
- Whenever partially completed inventories are present, the number of equivalent units of production must be computed. Basically, the concept of equivalent units involves expressing a given number of partially completed units as a smaller number of fully completed units.
- As a simple example of equivalent units, two apples that are half eaten are equivalent to one whole apple eaten. In manufacturing, we estimate the degree of completion for a group of products with respect to transferred-in, materials, and conversion (direct labor and overhead). Accountants base the concept of equivalent units on the supposition that a company must incur approximately the same costs to partially complete a large number of units as to totally complete a smaller number of units.
- Accountants compute equivalent units of production for transferred-in units, materials, and conversion. For each of these categories, the number of units transferred out is added to the equivalent units remaining in ending work in process in the department.
- Unit costs for the three categories—transferred-in units, materials, and conversion—are determined by dividing the equivalent units into the cost in beginning inventory plus the costs transferred in or added in the department during this period.
- A production cost report shows both the flow of units and the flow of costs through a processing center. The report is divided into two parts. The first part traces the physical flow of the units through the production department and converts actual units to equivalent units. The second part shows the costs to be accounted for, computes unit costs based on equivalent units as determined in the first part, and shows how the costs were accounted for by adding the costs completed and transferred out with the costs remaining in ending inventory. The costs to be accounted for and the costs accounted for must balance.

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- The production cost report provides a check on the Work in Process Inventory account. Each processing department normally has its own Work in Process Inventory account and related production cost report. The separate items that make up work in process inventory—direct labor, direct materials, applied overhead, and cost of units transferred in and out—can be traced from the production cost report to the Work in Process Inventory account (and vice versa) during a given period.
- Normal spoilage occurs in the normal course of production and is treated as a product cost. Abnormal spoilage exceeds the spoilage that occurs in the normal course of production and is treated as a period cost.
- Under FIFO equivalent units of production are computed by taking the equivalent units of work done to complete the beginning inventory, plus units started and completed during the current period, plus equivalent units of work done on the ending inventory. As is true under the average cost method, the equivalent units usually differ between materials and conversion.
- Unit costs for the three categories—transferred-in units, materials, and conversion—are determined by dividing cost to be accounted for during the period by units produced during the period.
- The physical measures method allocates joint product costs based on physical measures, such as units, pounds, or liters.
- The relative sales value method is the most commonly used method to allocate joint product costs. It is based on the relative sales values of the products at the split-off point.

Appendix 19A: The FIFO process cost method

In this chapter, the discussion assumed the use of the average cost method for determining unit costs under process costing. Another acceptable method for determining unit cost under process costing is the first-in, first-out (FIFO) cost method. This appendix presents a detailed illustration of the FIFO process costing system.

The following table shows how the computation of equivalent units differs between the average cost method and the FIFO cost method:

Average cost method	FIFO cost method
Equivalent units of production = Units completed this period + Equivalent units of work done on the ending inventory	Equivalent units of production = equivalent units of work done to complete the beginning inventory + units started and completed this period + Equivalent units of work done on the ending inventory

To illustrate the computation of equivalent units under the FIFO method, assume the following facts:

Beginning inventory, 3,000 units, 40% complete
 Units started this period, 10,000 units
 Ending inventory, 5,000 units, 20% complete

The equivalent production for the period would be:

Equivalent units of work done to complete the beginning inventory (3,000 × 0.60)	1,800
Units started and completed this period (10,000 – 5,000 in ending inventory)	5,000
Equivalent units of work done to partially complete the ending inventory (5,000 × 0.20)	1,000
Equivalent units of production	7,800

As is true under the average cost method, the number of equivalent units usually differs between materials and conversion.

FIFO process costing—An illustration

To illustrate more completely the operation of the FIFO process cost method, we use an example of the month of June production costs for a company having Departments A and B. Both departments add materials only at the beginning of processing. Department A has no May 31 inventory. The May 31 inventory in Department B consists of 2,000 units that are fully complete as to materials and 50 per cent complete as to conversion. This inventory has accumulated costs of USD 6,180.

The following transactions and additional data summarize manufacturing operations in both departments for June:

Raw materials purchased on account, USD 25,000.

Direct materials issued: Department A (14,000 units at USD 1.50), USD 21,000; and Department B (10,000 units at USD 0.13), USD 1,300.

Indirect materials issued: Department A, USD 400; and Department B, USD 200.

Labor costs: direct labor, Department A, USD 6,600, Department B, USD 5,400; and indirect labor, USD 3,000.

Manufacturing overhead is applied as follows: USD 5,280 in Department A and USD 5,400 in Department B.

Other manufacturing overhead incurred:

Repairs (on account)	\$2,100
Depreciation	3,000
Utilities (on account)	3,000
	\$8,100

- Production reports show the following for June:

	Department A	Department B
Beginning inventory	-0-	2,000
Units started	14,000	10,000
Units completed and transferred out	10,000	9,000
Units in inventory, June 30	4,000	3,000
Estimated percentage	50	33 1/3

- Sales for the month on account, 15,000 units at USD 6 per unit.
- The company computed cost of goods sold at USD 55,866 on a FIFO basis.

The general journal entries and their explanation follow:

1.	Materials inventory (+A)	25,000	
	Accounts payable (+L)		25,000
	To record materials purchased on account.		
2.	Work in process – Department A (+A)	21,000	
	Work in process – Department B (+A)	1,300	
	Manufacturing overhead (-SE)	600	
	Materials inventory (+L)		22,900
	To record direct and indirect materials used.		
3.	Work in process – Department A (+A)	6,600	
	Work in process – Department B (+A)	5,400	
	Manufacturing overhead (+SE)	3,000	
	Payroll summary (-SE)		15,000
	To distribute labor.		
4.	Work in process – Department A (+L)	5,280	
	Work in process – Department B (-A)	5,400	

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Manufacturing overhead (+A) To record assignment of overhead to production.		10,680	
5. Manufacturing overhead (-A)	8,100		
Accounts payable (+A)		5,100	
Accumulated depreciation – Plant and equipment (-A)		3,000	
To record various overhead costs incurred.			
6. Work in process – Department B (+A)	24,900		
Work in process – Department A (+SE)		24,900	
To record transfer of completed production from Department A to Department B. (For details of computation, see production cost report of Department A in Exhibit 6).			
7. Accounts receivable (-SE)	90,000		
Sales (-A)		90,000	
To record sales for the month.			
8. Cost of goods sold	55,866		
Finished goods		55,866	
To record cost of goods sold.			

As noted in the journal entries for June's manufacturing operations, the production cost report provided the dollar amounts of certain entries. For product costing purposes, the production cost report is the primary report in a process cost system. The chapter illustration of the production cost report shows the units and costs charged to a department, the disposition of these units and costs, and, typically, some of the supporting details and computations.

Production cost report—Department A To illustrate flexibility in format, Exhibit 5 shows the production cost report for Department A in a format different from the one in the chapter. Note that Department A placed 14,000 units into production. Then, Department A completed and transferred out 10,000 units. Department A retained the remaining 4,000 partially completed units in the department. The footnote in the illustration shows the computation of equivalent units.

Department A			
Production cost report			
For the month ended 2011 June 30			
Units in beginning inventory		-0-	
Units started during period		14,000	
Units to be accounted for		14,000	
Units completed and transferred out		10,000	
Units in ending inventory		4,000	
Units accounted for		14,000	
Costs	Equivalent units	Total cost	Current unit cost
Costs to be accounted for:			
Costs added during the month:			
Direct materials	14,000*	\$21,000	\$1.50
Conversion	12,000*	11,880	0.99
Costs added in month and costs to be accounted for		\$32,880	\$2.49
Costs accounted for:			
Cost of ending inventory:			
Direct materials (4,000 x 100% x \$1.50)		\$6,000	
Conversion (4,000 x 50% x \$0.99)		1,980	
Total cost of ending inventory		\$7,980	
Cost of 10,000 units transferred out		24,900	\$2.49
Costs accounted for		\$32,880	

*Supporting computations and data:

	Materials	Conversion
Computations of equivalent units:		
Equivalent units to complete beginning inventory	-0-	-0-
Units started and completed	10,000	10,000
Equivalent units in partially completed ending inventory	4,000	2,000
Equivalent units of production for month	14,000	12,000

	Materials	Conversion
Computations of equivalent units:		
Equivalent units to complete beginning inventory	-0-	-0-
Units started and completed	10,000	10,000
Equivalent units in partially completed ending inventory	4,000	2,000
Equivalent units of production for month	14,000	12,000

Exhibit 5: Production cost report—Department A

The costs section of the report shows that the only costs to be accounted for were those added in the department in June. These costs include USD 21,000 for materials and USD 11,880 for conversion, totaling USD 32,880. Department A had no beginning inventory and no transfers in. Note how Department A determines its unit costs for each of the two elements of manufacturing costs (USD 1.50 for materials and USD 0.99 for conversion). The total current unit cost is USD 2.49. The report shows the disposition of the costs—the cost of the units transferred to Department B (USD 24,900) and the amount of ending inventory remaining in Department A (USD 7,980 based on current unit costs). The units transferred to Department B have the same unit cost as the unit cost in Department A for the month. The current unit cost and the cost of the transferred units is not always the same, as we will show for Department B in Exhibit 6.

Department B Production cost report For the month ended 2011 June 30

Units			
Units in beginning inventory		2,000	
Units started during period		10,000	
Units to be accounted for		12,000	
Units completed and transferred out		9,000	
Units in ending inventory		3,000	
Units accounted for		12,000	
Costs	Equivalent units	Total cost	Current unit cost
Costs to be accounted for:			
Costs added during the month:			
Direct materials	10,000*	\$ 1,300	\$ 0.13
Conversion	9,000*	10,800	1.20
Costs added during the month		\$12,100	\$ 1.33
Costs in beginning inventory		6,180	
Costs transferred in from Department A		24,900	
Total costs to be accounted for		\$43,180	
Costs accounted for:			
Cost of ending inventory:			
Transferred in from Department A (3,000 units at \$2.49)		\$ 7,340	
Direct materials (3,000 x 100% x \$0.13)		390	
Conversion (3,000 x 1/3 x \$1.20)		1,200	
Total cost of ending inventory		\$ 9,060	
Cost of 9,000 units transferred out		34,120	\$3.791

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Costs accounted for	\$43,180	
*Supporting computations and data:		
	Materials	Conversion
Computations of equivalent units:		
Equivalent units to complete beginning inventory	-0-	1,000
Units started and completed	7,000	7,000
Equivalent units in partially completed ending inventory	3,000	1,000
Equivalent units of production for the month	10,000	9,000

Beginning and ending inventories are complete as to materials. Beginning inventory is 50% complete and ending inventory 33 1/2% complete as to processing.

Exhibit 6: Production cost report—Department B

Production cost report—Department B The production cost report for Department B (Exhibit 6) is similar to that of Department A. Note how the report highlights the current unit cost of the operations performed in the department. Note also that Department B must account for the costs in the beginning inventory and the cost of the units transferred in from Department A. Department B determines the cost of the ending inventory through the use of the current month's unit cost (USD 1.33). All of Department B's other costs are included in the costs of the 9,000 units transferred to Finished Goods.

In the production cost report in Exhibit 6, we determine the cost of units transferred out by subtracting the cost of the ending inventory from the total costs to be accounted for (USD 43,180 - USD 9,060 = USD 34,120). We can compute average unit cost of USD 3.791 by dividing USD 34,120 by the 9,000 units transferred out.

Appendix 19B: Allocation of joint costs

A company incurs **joint costs** when it produces two or more products through the same production process or from a common raw material. The company produces these products simultaneously. The products are not identifiable as different individual products until a particular point in the manufacturing process known as the split-off point.

The **split-off point** is a certain stage of production at which the separate products become identifiable from a common processing unit. We refer to any costs beyond the split-off point as separable costs because they can be directly traced to individual products. Examples of joint products are petroleum products, lumber, flour milling, dairy products, and chemicals. In Exhibit 7, we show the joint production process.

By definition, joint costs are not identified with individual products. Any allocation of joint costs to one of the products is inherently arbitrary. Many companies do not allocate joint costs to particular products for managerial decision making because the allocated numbers could be misleading to decision makers.¹ The accounting problem we face is how to allocate the joint costs that a company incurred before the products become separately identified. Commonly used methods to allocate joint costs are the physical measures method and the relative sales value method.

The **physical measures method** allocates joint costs on the basis of physical measures such as units, pounds, or liters.

¹ For example, a survey of oil refineries indicated that seven of the nine companies did not allocate joint costs. See K. Slater and C. Wooton, *A Study of Joint and By-Product Costing in the U.K.* (Reprint, London: Chartered Institute of Management Accountants, 1988), p. 110.

To illustrate, assume that Roy Company produces two grades of oil, product A and product B, through a joint process. The cost and production data of Roy Company for July are:

	Product A	Product B	Total
Units (barrels) produced	15,000	25,000	40,000
Unit selling price at split-off	\$ 15	\$ 6	
Revenue at split-off	\$225,000	\$150,000	
Joint product costs:			
Direct materials			\$125,000
Direct labor			105,000
Manufacturing overhead			70,000
			\$300,000

Illustration 19.8 Production Cost Report—Department B



Exhibit 7: Production cost report-Department B

The physical measures method uses a ratio of the physical volume of each product to total volume as a basis for allocation of joint costs. We compute the allocation of joint costs to each product as follows:

	Total barrels	Ratio	Joint costs	Allocated joint costs
Product A	15,000	$\frac{15,000}{40,000}$	$15,000 \times \$300,000$	\$112,500
Product B	25,000	$\frac{25,000}{40,000}$	$25,000 \times \$300,000$	187,500
	40,000			\$300,000

If Roy Company sells both products without further processing, the gross margin for product A is USD 112,500, or USD 225,000 less USD 112,500. Product B incurs a loss of USD 37,500, or USD 150,000 less USD 187,500. Even though the physical measures method is easy to use, it often has no relationship to the revenue-generating power of each product. In this instance, product B suffers a loss of USD 37,500 because the company allocated a high portion of joint costs based on product B's high volume of physical units even though its selling price is less than that of product A.

Keep in mind that the joint costs cannot be directly assigned to one product because joint costs are inseparable between the products. Thus, because any allocation of joint costs to one product is arbitrary, the resulting measures of each product's income are arbitrary.

The **relative sales value method** is a commonly used basis to allocate joint costs at the split-off point. Accountants use the relative sales value method because it matches joint costs with revenue much like the matching concept.

Using the relative sales value method, Roy Company would allocate the joint costs as follows:

	Sales value at split-off	Ratio	Joint costs	Allocated joint costs
Product A:	\$225,000	$\frac{225,000}{375,000}$	$225,000 \times \$300,000$	\$180,000
(\$15 x 15,000)			\$375,000	
Product B:	150,000	$\frac{150,000}{375,000}$	$150,000 \times \$300,000$	120,000
(\$6 x 25,000)			\$375,000	
	\$375,000			\$300,000

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The allocation ratios of 60 per cent and 40 per cent, respectively, for product A and product B result in allocated joint costs of USD 180,000 to product A, and USD 120,000 to product B.

To compare the physical measures method and the relative sales value method, assume Roy Company has no inventory at the end of July. A partial July income statement would appear as shown:

	Product A		Product B	
	Physical Measures Method	Relative Sales Value Method	Physical Measures Method	Relative Sales Value Method
Sales	\$225,000	\$225,000	\$150,000	\$150,000
Cost of goods sold	112,500	180,000	187,500	120,000
Gross margin	\$112,500	\$ 45,000	\$(37,500)	\$ 30,000

Demonstration problem

Zarro, Inc., uses a process cost system to accumulate the costs it incurs to produce aluminum awning stabilizers from recycled aluminum cans. The May 1 inventory in the finishing department consisted of 36,000 units, fully complete as to materials and 80 per cent complete as to conversion. The beginning inventory cost of USD 288,000 consisted of USD 216,000 of costs transferred in from the molding department, USD 30,000 of finishing department materials costs, and USD 42,000 of finishing department conversion costs (conversion costs are direct labor and overhead). The costs incurred in the finishing department for May appear as follows:

Costs transferred in from molding department (excluding costs in beginning inventory)		\$720,000	
Costs added in finishing department in May (excluding costs in beginning inventory):	\$63,600		
Materials	131,376	194,976	
Conversion costs		\$914,976	

The finishing department received 120,000 units from the molding department in May. During May, 127,200 units were completed by the finishing department and transferred out. As of May 31, 28,800 units, complete as to materials and 60 per cent complete as to conversion, were left in inventory of the finishing department.

- Using the average cost procedure, prepare a production cost report for the finishing department for May.
- Compute the average unit cost for conversion in the finishing department in April.

Solution to demonstration problem

a.

Zarbo, Inc.				
Finishing department				
Production cost report				
For the month ending				
May 31				
Units	Actual units	Transferred -in	Equivalent units Materials	Conversion
Units in May 1 inventory	36,000			
Units transferred in	120,000			
Units to be accounted for	156,000			
Units completed and transferred out	127,000	127,200	127,200	127,200*
Units in May 31 inventory*	28,800	28,800	28,800	17,280†
Units accounted for	156,000	156,000	156,000	144,480

*Inventory is complete as to materials, 60% complete as to conversion.

†(28,800 x 60% = 17,280).

Costs	Transferred -in	Materials	Conversion	Total
Costs to be accounted for:				
Costs in May 1 inventory	\$216,000	\$30,000	\$42,000*	\$288,000
Costs transferred in	720,000			720,000

Costs added in department	63,600	131,376	194,976	
Costs to be accounted for	\$936,000	\$93,600	\$ 173,376	\$1,202,976
Equivalent units (from above)	156,000	156,000	144,480	
Unit costs	\$ 6.00	\$ 0.60	\$ 1.20	\$7.80
Costs accounted for:				
Units completed and transferred out (127,200 units)	\$763,200	\$76,320	\$ 152,640*	\$992,160
Units remaining in May 31 inventory (28,800 units)	172,800	17,280	20,736*	210,816
Costs accounted for	\$936,000	\$93,600	\$173,376	\$1,202,976

*17,280 equivalent units x \$1.20 = \$20,736.

b. The average unit cost for conversion in the finishing department in April was USD 1.46, calculated as $\frac{\text{USD}42,000}{(0.8 \times 36,000)}$.

Key terms

Abnormal spoilage Spoilage that exceeds the amount expected under normal operating conditions.

Average cost procedure A method of computing equivalent units where the number of equivalent units for each cost element equals the number of units transferred out plus the number of equivalent units of that cost element in the ending inventory.

Conversion costs Costs of converting raw materials into the final product. Direct labor plus overhead.

Equivalent units A method of expressing a given number of partially completed units as a smaller number of fully completed units; for example, bringing 1,000 units to a 75 per cent level of completion is the equivalent of bringing 750 units to a 100 per cent level of completion.

First-in, first-out (FIFO) method A method of determining unit cost. This method computes equivalent units by adding equivalent units of work needed to complete the units in beginning inventory, work done on units started and completed during the period, and work done on partially completed units in ending inventory.

Job cost system (job costing) A manufacturing cost system that accumulates costs incurred to produce a product according to individual jobs.

Joint costs Those production costs incurred up to the point where the joint products split off from each other.

Normal spoilage Spoilage that occurs in the normal production process.

Physical measures method A method of allocating joint product costs on the basis of physical measures such as units, pounds, or liters.

Process cost system (process costing) A manufacturing cost system that accumulates costs incurred to produce a product according to the processes or departments a product goes through on its way to completion.

Production cost report A report that shows both the flow of units and the flow of costs through a processing center. It also shows how accountants divide these costs between the cost of units completed and transferred out and the cost of units still in the processing center's ending inventory.

Relative sales value method A method of allocating joint product costs on the basis of the relative market value at the split-off point.

Split-off point A certain stage of production at which the separate products become identifiable from a common processing unit.

Spoilage The loss of goods during production.

Transferred-in costs Costs associated with physical units that were accumulated in previous processing centers.

Self-test

True-false

Indicate whether each of the following statements is true or false.

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In process costing, costs are accumulated by process or department.

Both job and process cost systems can only have one Work in Process Inventory account.

The first step in computing equivalent units is to determine the amount of materials being used.

Abnormal spoilage is treated as a product cost.

(Based on Appendix 19-B.) A commonly used basis to allocate joint costs is the relative sales value of the products at the split-off point.

Multiple choice

Select the best answer for each of the following questions.

Which of the following does not apply to process costing?

- a. Uses the equivalent unit concept.
- b. Includes overhead in product costs.
- c. Costs of production are first recorded in Work in Process Inventory accounts then transferred to Finished Goods Inventory and Cost of Goods Sold.
- d. Keeps track of the actual cost of each individual unit produced.

Which of the following formulas is the correct formula for equivalent units of production under the average cost procedure?

- a. $\text{Units completed} - [\text{Units in ending inventory} \times \text{Percentage complete}] = \text{Equivalent production}$
- b. $\text{Units completed} - [\text{Units in beginning inventory} \times \text{Percentage complete}] = \text{Equivalent production}$
- c. $\text{Units completed} + [\text{Units in ending inventory} \times \text{Percentage complete}] = \text{Equivalent production}$
- d. None of the above.

Using the following data, compute the ending inventory cost:

1,000 units are in ending inventory in Department B. The 1,000 units are fully complete as to materials and 20 per cent complete as to conversion. The unit cost for materials is USD 0.05, and conversion unit cost equals USD 0.60. The unit cost of goods transferred in from Department A is USD 1.20.

- a. USD 1,370.
- b. USD 1,170.
- c. USD 1,320.
- d. USD 1,250.

A production cost report reports which of the following:

- a. Units in a production department.
- b. Costs related to production.

- c. Unit costs.
- d. Equivalent units.
- e. All of the above are included in the production cost report.

(Based on Appendix 19-A) Compute the equivalent units of production under the FIFO method using this data:

Beginning inventory, 1,500 units—40 per cent complete

Units started this period, 5,000 units

Ending inventory, 2,500 units—20 per cent complete

- a. 3,000.
- b. 3,900.
- c. 3,400.
- d. 3,600.

Now refer to “Answers to self-test” at the end of the chapter to check your answers.

Questions

- Define process costing and describe the types of companies that use process costing.
- How does a process cost system differ from a job costing system?
- Would a lumber mill use process or job costing?
- What is meant by the term equivalent units? Of what use is the computation of the numbers of equivalent units of production?
- Distinguish between the number of units completed and transferred during a period and the equivalent units for the same period.
- Under what circumstances would the number of equivalent units of materials differ from the number of equivalent units of labor and overhead in the same department in the same period? Under what circumstances would they be the same?
- When transferring goods from one department to another, which accounts require journal entries?
- Units are usually assumed to be at the same stage of completion for both labor and overhead. What is the reason for this assumption?
- What is the basic information conveyed by a production cost report?
- What are the four steps in preparing a production cost report?
- What is meant by average cost procedure? What other two cost flow assumptions could be used?
- Would an automobile plant that makes specialty race cars use job costing or process costing? Would an automobile plant that makes all terrain vehicles use job costing or process costing? Explain your answer.

19. Process: Cost systems

- What is the difference between normal and abnormal spoilage?
- Why might an advocate of total quality management prefer to see all spoilage labeled as abnormal?
- Show the differences between computing equivalent units of production using the average cost method and FIFO cost method (Appendix 19A).
- Describe the relative sales value method and show how it is used (Appendix 19B).
- **Real world question** Refer to "A broader perspective: Producing cans of Coca-Cola". Describe the different processes used in a cola bottling plant.
- **Real world question** Does The Coca-Cola Company use a process cost system or a job costing system in its bottling plants? Why?
- **Real world question** Name five companies that probably use process costing.

Exercises

Exercise A Using the average cost method, compute the equivalent units of production in each of the following cases:

a. Units started in production during the month, 72,000; units completed and transferred, 52,800; and units in process at the end of the month (100 per cent complete as to materials; 60 per cent complete as to conversion), 19,200. (There was no beginning inventory.)

b. Units in process at the beginning of the month (100 per cent complete as to materials; 30 per cent complete as to conversion), 12,000; units started during the month, 48,000; and units in process at the end of the month (100 per cent complete as to materials; 40 per cent complete as to conversion), 24,000.

Exercise B In Department C, materials are added at the beginning of the process. There were 1,000 units in beginning inventory, 10,000 units were started during the month, and 7,000 units were completed and transferred to finished goods inventory. The ending inventory in Department C in June was 40 per cent complete as to conversion costs. Under the average cost method, what are the equivalent units of production for materials and conversion?

Exercise C In Department D, materials are added uniformly throughout processing. The beginning inventory was considered 80 per cent complete, as was the ending inventory. Assume that there were 6,000 units in the beginning inventory and 20,000 in the ending inventory, and that 80,000 units were completed and transferred out of Department D. What are the equivalent units for the period using the average cost method?

Exercise D If in the previous exercise the total costs charged to the department amounted to USD 960,000, including the USD 48,000 cost of the beginning inventory, what is the cost of the units completed and transferred out?

Exercise E The following data relate to Work in Process—Department C, in which all materials are added at the start of processing:

**Work in process – Department C:
Inventory, March 1:**

Materials cost (1,200 pounds; 100% complete)	\$7,020
--	---------

Conversion cost (20% complete)	1,804
Costs incurred this period:	
Direct materials used (9,000 pounds)	\$36,330
Direct labor	10,880
Overhead	17,820
Inventory, March 31	
Materials cost (1,800 pounds, 100% complete)	?
Conversion cost (1,800 pounds, 80% complete)	?
Pounds of product transferred out:	8,400

Using these data, compute:

- The unit cost per equivalent unit for materials and conversion (use the average cost method).
- The cost of the product transferred out.

Problems

Problem A The following data refer to a production center of Sipp-Fizz, a soft drink bottler:

Work in process inventory, August 1, 4,000 units (units equal 12-bottle cases):	
Direct materials	\$12,000
Direct labor	6,120
Manufacturing overhead applied	8,000
	\$26,120
Units started in August	12,000
Costs incurred in August:	
Direct materials	\$36,000
Direct labor	48,000
Manufacturing overhead applied	60,000

The beginning inventory was 100 per cent complete for materials and 50 per cent complete for conversion costs.

The ending inventory on August 31 consisted of 6,000 units (100 per cent complete for materials, 70 per cent complete for conversion costs).

Compute the following:

- Number of units completed and transferred to finished goods inventory.
- The equivalent units of production for materials and conversion costs using the average cost method.
- Cost per equivalent unit for materials and conversion costs.
- Cost of units completed and transferred.
- Cost of ending inventory.

Problem B The following information relates to Aromatic Company for its line of perfume products for the month ended March 31:

Units in beginning inventory (units equal cases of product)	2,7000
Cost of units in beginning inventory:	
Materials	\$40,500
Conversion	\$ 18,900
Units placed in production	54,000
Cost incurred during current period:	
Materials	\$239,598
Conversion	\$215,310
Units remaining in ending inventory (100% complete as to materials,	3,000

19. Process: Cost systems

60% complete as to conversion)

Prepare a production cost report for the month ended March 31, using the average cost method.

Problem C Shine Company uses a process cost system to account for the costs incurred in making its single product, a hair conditioner. This product is processed in Department A and then in Department B. Materials are added in both departments. Production for May was as follows:

	Department A	Department B
Units started or transferred in	200,000	160,000
Units completed and transferred out	160,000	120,000
Stage of completion of May 31 inventory:		
Materials	100%	80%
Conversion	50%	40%
Costs incurred this month:		
Direct materials costs	\$200,000	\$304,000
Conversion costs	\$540,000	\$272,000

There was no May 1 inventory in either department.

- Prepare a production cost report for Department A in May.
- Prepare a production cost report for Department B in May.

Problem D A bottling company bottles soft drinks using a process cost system. Following are cost and production data for the mixing department for June:

	Units	Materials costs	Conversion costs
Inventory, June 1	56,000	\$11,620	\$16,240
Placed in production in June	133,000	29,960	41,720
Inventory, June 30	63,000	?	?

The June 30 inventory was 100 per cent complete as to materials and 30 per cent complete as to conversion.

Prepare a production cost report for the month ended June 30 using the average cost method.

Problem E Refer to the facts given in the previous problem. Assume the beginning inventory on June 1 was 100 per cent complete as to materials and 25 per cent complete as to conversion.

- Prepare a production cost report for the month ended June 30, using FIFO. Round unit costs to the nearest cent.
- Why are ending inventory amounts different than those for the previous problem?

Problem F Quality Lumber Company produces two products from logs, Grade A lumber and Grade B lumber. The following events took place in June:

	Grade A	Grade B	Total
Units produced	80,000	120,000	200,000
Unit selling price at split-off	\$4.00	\$2.00	
Joint costs	?	?	\$120,000

- Allocate the joint costs to the two products using the physical measures method.
- Allocate the joint costs to the two products using the relative sales value method.
- Explain the difference in unit costs using the two methods.
- What are advantages of the relative sales value method if all of Grade A lumber has been sold and none of Grade B lumber has been sold at the end of a month?

Alternate problems

Alternate problem A Pure Aqua Company is a producer of flavored mineral water. These data are for its March production:

Work in process inventory, March 1, 3,000 (units equal cases):	
Direct materials	\$12,600
Direct labor	6,000
Manufacturing overhead (1,500 machine-hours at \$6 per machine-hours)	9,000
	\$27,600
Units started in March	9,000
Costs incurred in March:	
Direct materials	\$36,360
Direct labor	55,200
Manufacturing overhead applied (13,800 machine-hours)	?

The ending inventory consisted of 4,500 units (100 per cent complete as to materials, 60 per cent complete as to conversion).

Compute the following:

- Number of units completed and transferred to finished goods inventory.
- The equivalent units of production for materials and conversion costs using the average cost method.
- Cost per equivalent unit for materials and conversion costs.
- Cost of units completed and transferred.
- Cost of ending inventory.

Alternate problem B The following data pertain to a production center of Sunbelt Company, a maker of sunscreen products:

	Units	Materials costs	Conversion costs
Inventory, October 1	70,000	\$12,000	\$16,000
Placed in production in October	200,000	20,400	18,200
Inventory, October 31	100,000	?	?

The October 31 inventory was 100 per cent complete as to materials and 20 per cent complete as to conversion costs.

Prepare a production cost report for the month ended October 31, using the average cost method.

Alternate problem C Healthbar Company produces a health food and determines product costs using a process cost system. The product is moved through two departments, mixing and bottling. Production and cost data for the bottling department in August follow.

Work in process, August 1 (30,000 pints):	
Costs transferred in	\$30,000
Materials costs	15,000
Conversion costs	9,000
Costs incurred in August:	
Transferred in (100,000 pints)	\$100,00
	0
Materials costs	50,000
Conversion costs	39,300

All materials are added at the beginning of the bottling process. Ending inventory consists of 25,000 pints, 100 per cent complete as to materials and 40 per cent complete as to conversion.

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Prepare a production cost report for August using the average cost method.

Beyond the numbers—Critical thinking

Business decision case A Bicycles Plus, Inc., produces bicycles. While the company has developed a per unit cost, it has not been able to break down its costs in each of its three departments: frames, assembling, and finishing. Karol Ring, the production manager, has been concerned with cost overruns during July in the frames department, which produces the bicycle frames.

On July 1, the frames department had 6,000 units in its work in process inventory. These units were 100 per cent complete as to materials and 40 per cent complete as to conversion. The department had incurred USD 12,000 in materials costs and USD 90,000 in conversion costs in processing these 6,000 units.

The department handled 30,000 units during the month, including the 6,000 units in beginning inventory on July 1. At the end of the month, the department's work in process included 3,600 units that were 100 per cent complete as to materials and 30 per cent complete as to conversion. The month's costs were allocated on the number of units processed during the month as follows:

	Materials	Conversion
Costs	\$60,000	\$300,216
Units handled during month	30,000	30,000
Cost per unit	\$ 2	\$ 10

The USD 12 per unit cost was assigned in a way that resulted in the following costs:

	Beginning work in process	Work started and completed	Ending work in process
Cost per unit incurred during the month:			
Units	6,000	20,400	3,600
Cost per unit	\$12	\$12	\$12

Ring realized that this per unit cost is incorrect and asks you to develop a better method of computing these costs for the month ended July 31.

- a. How would you recommend that July's costs be assigned to the units produced? How would this differ from the present method?
- b. To justify your recommendation, recalculate July's costs using your recommendation. Present your analysis in a production cost report.

Ethics case – Writing experience B Steve Yung works in the inventory control group at a company that produces stone-washed jeans. A good friend manages the Stitching Department at the same company. At the end of a recent month, Yung reviewed the Stitching Department's production cost report and found the department had no beginning Work in Process Inventory, had started 27,000 pairs of jeans, and had produced only 24,000 pairs. That leaves 3,000 pairs in ending inventory, Yung thought, that is a lot of jeans they did not finish.

Later, Yung visited his friend who managed the Stitching Department. "Why all the ending inventory?" he asked.

"One of the new workers set several machines wrong, and the stitching was bad on 2,400 pairs," the manager replied. "We set those aside, and we will fix them when we have some free time. The other 600 pairs are complete now, and have been transferred out. Our entire operation was slower because of the machine problem."

"Company policy is to send all defective products to the Rework Department. They can fix the jeans. That is their job," Yung said.

"No way!" exclaimed the Stitching Department manager. "We would all be in trouble if plant management finds out. The worker who messed up would probably be fired. I do not want that. This is our little problem, and we will take care of it."

- a. What should Yung do?
- b. Would your answer change if Yung learned that the Stitching Department had fixed the jeans and sent them on to the next department?

Financial analysis C Suppose a bottling company made an error in estimating the stage of completion of its work in process inventory. Suppose the costs in beginning inventory and the costs transferred in were correct, but the company overstated the stage of completion for both materials and conversion costs in ending Work in Process Inventory causing ending Work in Process Inventory to be USD 100,000 too high. The beginning and ending Finished Goods Inventory amounts are correct. What effect would this error have on the company's last year's financial statements?

Group project D In groups of 3 or 4 students, write a paper on the topic, "How scientific is the allocation of joint costs to products?" Prepare the paper on a computer and prepare and edit several drafts before turning in the final paper. Use examples to demonstrate your points.

Group project E In teams of two or three students, interview the manager of a grocery store. What is the cost of spoilage in the vegetable and fruit section as a percentage of the total cost of goods sold? Does the manager differentiate between normal and abnormal spoilage? If so, provide some examples. Each team should write a memorandum to the instructor summarizing the results of the interview. Information contained in the memo should include:

Date:

To:

From:

Subject:

Content of the memo must include the name and title of the person interviewed, name of the company, and information responding to the questions above.

Group project F In teams of two or three students, interview the manager of a fast food restaurant such as McDonald's. What is the cost of spoilage as a percentage of the total cost of goods sold? Does the manager differentiate between normal and abnormal spoilage? If so, provide some examples. Each team should write a memorandum to the instructor summarizing the results of the interview. Information contained in the memo should include:

Date:

To:

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From:

Subject:

Content of the memo must include the name and title of the person interviewed, name of the company, and information responding to the questions above.

Using the Internet—A view of the real world

Using the Internet as a research tool, describe the conversion activities (or processes) involved in producing oil or oil-related products. Your description should include examples of raw materials used as inputs, production activities required to convert inputs into products, and resulting outputs (finished goods). Write your report in the form of a memorandum. The heading of the memorandum should contain the date, to whom it is written, from whom, and the subject matter. Be sure to attach your research materials obtained from the Internet to the memorandum.

Using the Internet as a research tool, describe the conversion activities (or processes) involved in producing milk or milk-related products. Your description should include examples of raw materials used as inputs, production activities required to convert inputs into products, and resulting outputs (finished goods). Write your report in the form of a memorandum. The heading of the memorandum should contain the date, to whom it is written, from whom, and the subject matter. Be sure to attach your research materials obtained from the Internet to the memorandum.

Answers to self-test

True-false

True. In process costing, costs are accumulated by process or department.

False. Job cost systems have one Work in Process Inventory account for each job, and process cost systems have a Work in Process Inventory account for each process or department.

False. The initial step in computing equivalent units is to determine either the stage of completion or the number of partially complete units.

False. Abnormal spoilage is treated as a period cost.

True. The relative sales value of the products at the split-off point is a commonly used basis to allocate joint costs.

Multiple-choice

d. Process costing does not keep track of the actual cost of each individual unit produced.

c. $\text{Units completed} + [\text{Units in ending inventory} \times \text{Percentage complete}] = \text{Equivalent production}$

a. USD 1,370 $[\text{USD } 1,200 + (1,000 \times \text{USD } .05) + (200 \times \text{USD } .60)]$

e. Items **a** through **d** are included in the production cost report.

b. The equivalent production for the period would be:

Equivalent units of work done to complete the beginning inventory 900
(1,500 × 0.60)

Units started and completed this period (5,000 – 2,500)	2,500
Equivalent units of work done to partially complete the 500 ending inventory (2,500 x 0.20)	
Equivalent units of production	3,900

Comprehensive review problem

The Compack Company assembles personal computers. Personal computers go through several departments where sub assemblies are unpacked and checked, the circuit board is attached, the product is tested and repaired if defective, and the computers are packed carefully for shipping. Each order is treated as a job, and the entire job is shipped at once. The company keeps track of costs by job and calculates the equivalent stage of completion for each job based on machine-hours.

Although the company has grown rapidly, it has yet to show a profit. You have been called in as a consultant. Management believes some jobs are profitable and others are not, but it is not clear which are profitable. The accounting system is almost nonexistent; however, you piece together the following information for April:

- Production:

- Completed Job No. 101.
- Started and completed Job No. 102.
- Started Job No. 103.

- Inventory values:

- Work in process inventory:

March 31: Job No. 101	
Direct materials	\$60,000
Direct labor	9,600
Overhead	14,400
April 30: Job No. 103	
Direct materials	\$45,000
Direct labor	10,400
Overhead	15,600

b. Job No. 101 was exactly one-half finished in direct labor-hours and machine-hours at the beginning of April, and Job No. 103 was exactly one-half complete in direct labor-hours and machine-hours at the end of April. However, all of the direct materials necessary to do the entire job were charged to each job as soon as the job was started.

- There were no direct materials inventories or finished goods inventories at either March 31 or April 30.

- Manufacturing overhead is applied at USD 30 per machine-hour. The company used 1,600 machine-hours during April, 480 machine-hours on Job 101 and 600 machine-hours on Job 102. The actual overhead for the month of April was USD 50,000.

- Cost of goods sold (before adjustment for over applied or under applied overhead):

Job No. 101:	
Materials	\$60,000
Labor	?
Overhead	?
Total	?
Job No. 102:	
Materials	?

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Labor ?
Overhead ?
Total ?

- Overhead was applied to jobs using the predetermined rate of USD 30 per machine-hour. The same rate had been used since the company began operations. Over- or under applied overhead is debited or credited to Cost of Goods Sold.
 - All direct materials were purchased on account. Direct materials purchased in April amounted to USD 150,000.
 - Direct labor costs charged to jobs in April were USD 32,000. All labor costs were the same rate per hour for April for all laborers.
- a. Compute the cost of each job, whether in inventory or sold.
 - b. Show the transactions in journal entry form. Use a separate Work in Process Inventory account for each job.
 - c. Prepare an income statement for April assuming revenue was USD 250,000 and selling and administrative expenses were USD 60,000.