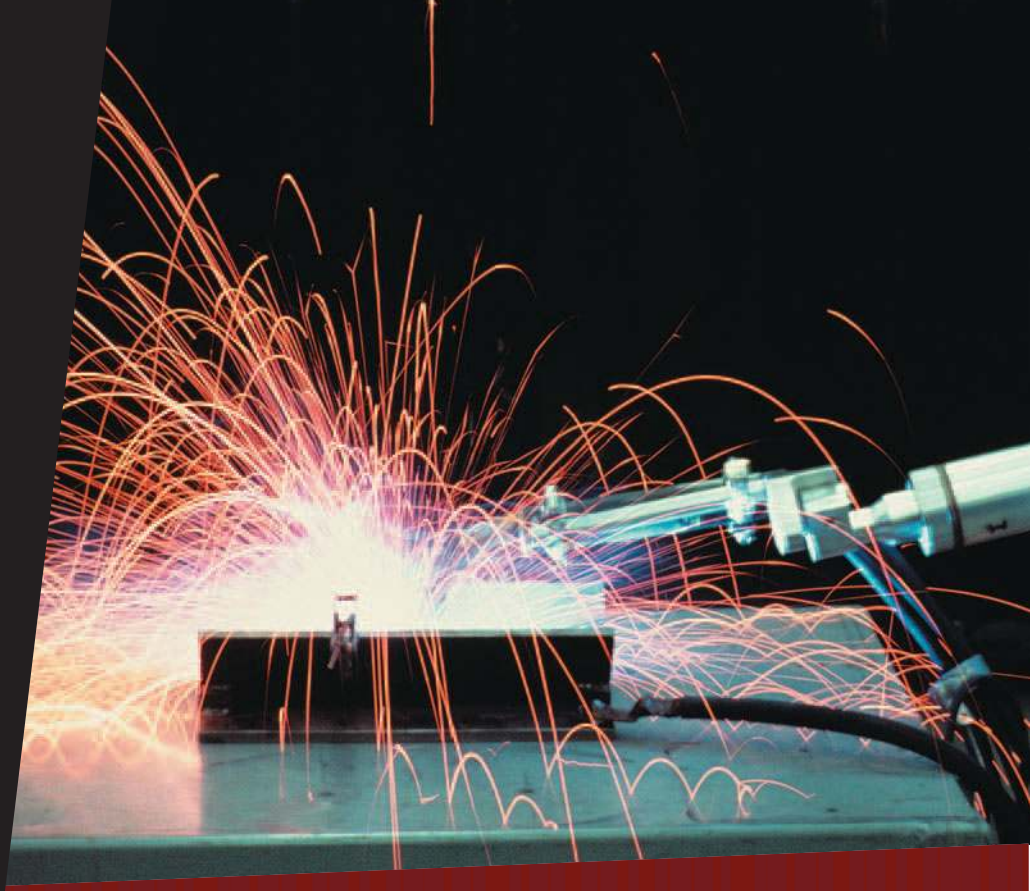


CHAPTER 6

Product and Service Costing: A Process Systems Approach

AFTER STUDYING THIS CHAPTER, YOU SHOULD BE ABLE TO:

1. Describe the basic characteristics of process costing, including cost flows, journal entries, and the cost of production report.
2. Describe process costing for settings without work-in-process inventories.
3. Define *equivalent units*, and explain their role in process costing.
4. Prepare a departmental production report using the FIFO method.
5. Prepare a departmental production report using the weighted average method.
6. Prepare a departmental production report with transferred-in goods and changes in output measures.
7. Describe the basic features of operation costing.
8. Explain how spoilage is treated in a process-costing system.

Process-Costing Systems: Basic Operational and Cost Concepts

To understand a process-costing system, it is necessary to understand the underlying operational system. An operational process system is characterized by a large number of homogeneous products passing through a series of *processes*, where each process is responsible for one or more operations that bring a product one step closer to completion. Thus, a **process** is a series of activities (operations) that are linked to perform

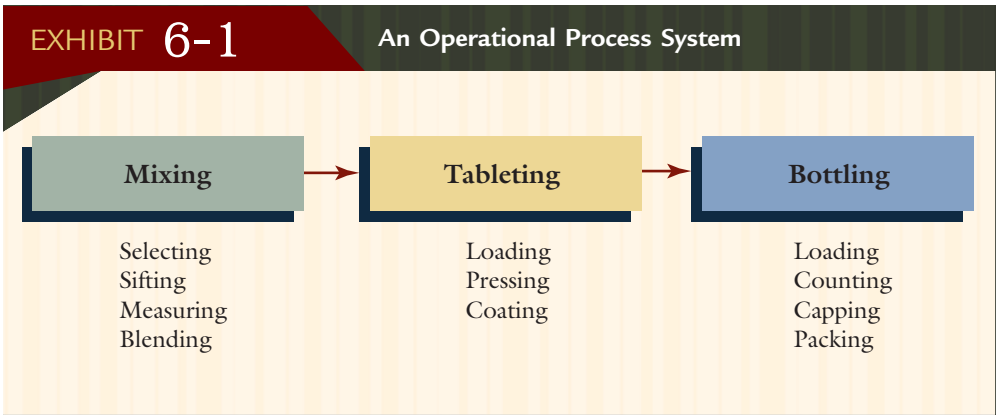
OBJECTIVE 1

Describe the basic characteristics of process costing, including cost flows, journal entries, and the cost of production report.

a specific objective. For example, Estrella Company, a manufacturer of a widely used pain medication has three processes: mixing, tableting, and bottling. Consider the mixing process. The mixing process consists of four linked activities: selecting, sifting, measuring, and blending. Direct laborers select the appropriate chemicals (active and inert ingredients), sift the materials to remove any foreign substances, and then the materials are *measured* and *combined* in a mixer to blend them thoroughly in the prescribed proportions.

In each process, materials, labor, and overhead inputs may be needed (typically in equal amounts for each unit of product). Upon completion of a particular process, the partially completed goods are transferred to another process. For example, when the mix prepared by the mixing department is finished, the resulting mixture is sent to the tableting process. The tableting process consists of three linked activities: loading, pressing, and coating. Initially, the blend is loaded into a machine and a binding agent is added, next the mixture is pressed into a tablet shape, and finally each tablet is coated to make swallowing easier. The final process is bottling. It has four linked activities: loading, counting, capping, and packing. Tablets are transferred to this department, loaded into a hopper, and automatically counted into bottles. Filled bottles are mechanically capped, and direct labor then manually packs the correct number of bottles into boxes that are transferred to the warehouse. Exhibit 6-1 summarizes the operational process system for the pain medication manufacturer.

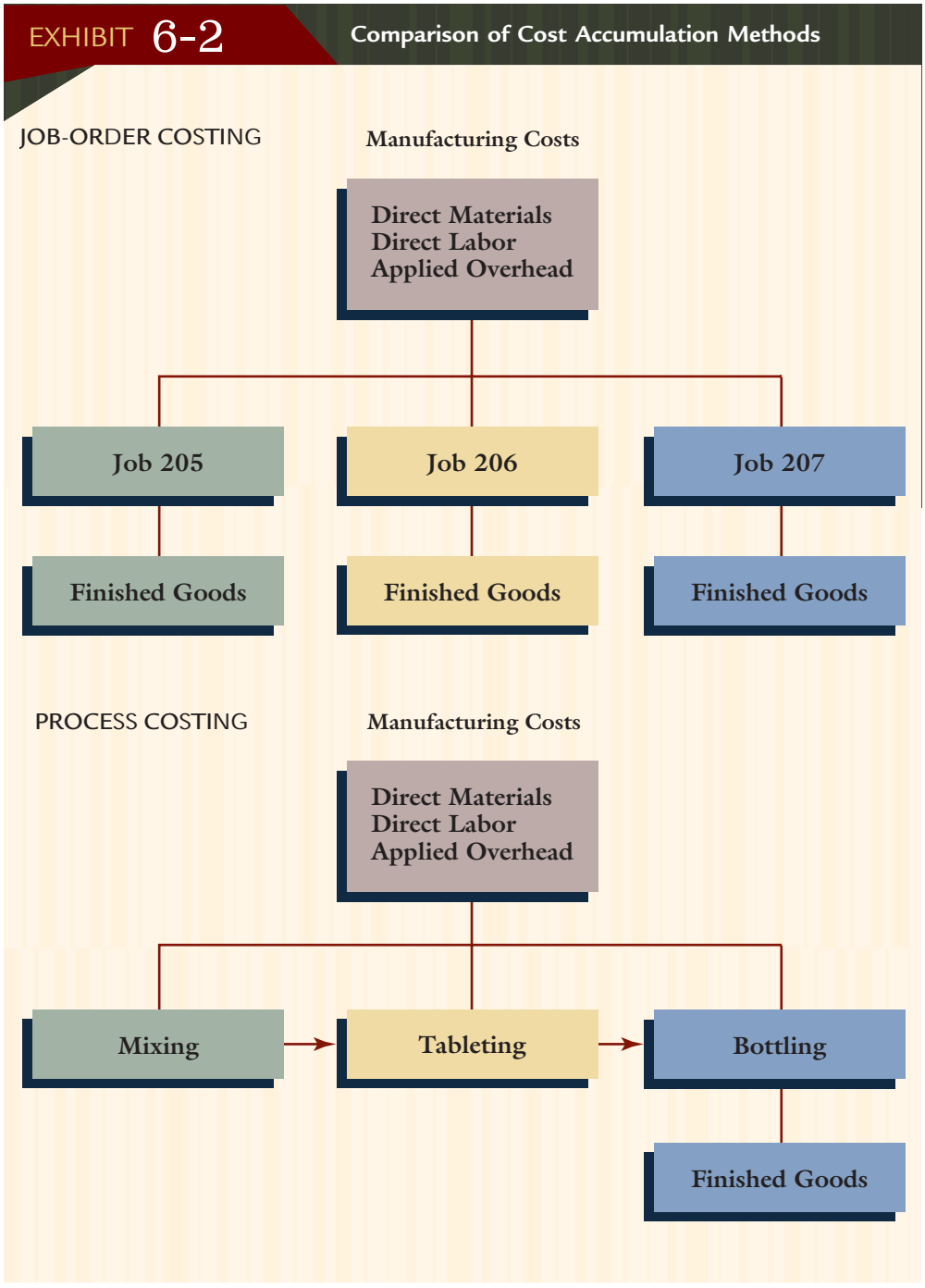
EXHIBIT 6-1 An Operational Process System



Cost Flows

The cost flows for a process-costing system are basically similar to those of a job-order costing system. There are two key differences. First, a job-order costing system accumulates production costs by job, and a process-costing system accumulates production costs by process. Second, for manufacturing firms, the job-order costing system uses a single work-in-process account, while the process-costing system has a work-in-process account for every process. Exhibit 6-2, on the following page, illustrates the first key difference: the different approaches to cost accumulation. Notice that job systems assign manufacturing costs to jobs (which act as subsidiary work-in-process accounts) and transfer these costs directly to the finished goods account when the job is completed. When units are finished for a process, manufacturing costs are transferred from one process department's account to the next. The last process transfers the costs to Finished Goods. Exhibit 6-3, on page 229, highlights the cost flow differences involving work-in-process accounts.

Exhibit 6-3 not only illustrates the use of multiple work-in-process accounts, but it also reveals some important concepts concerning the nature of process costing. Consider, for example, the journal entries for the tableting department.



1.	Work in Process—Tableting	600	
	Work in Process—Mixing		600
	To transfer goods to tableting.		
2.	Work in Process—Tableting	400	
	Materials		100
	Payroll		125
	Overhead Control		175
	To record additional manufacturing costs.		

EXHIBIT 6-3 Comparison Using Work-in-Process Accounts

Job-Order Costing

Work in Process			*Finished Goods*
DM	20,000	30,000 →	30,000
DL	10,000		
OH	15,000		

The transfer reflects completion of a job (or jobs) costing $30,000.

Process Costing

Work in Process—Mixing			*Work in Process—Tableting*			*Work in Process—Bottling*			*Finished Goods*
DM	350	600 →		600	800 →		800	1,200 →	1,200
DL	100		DM	100		DM	200		
OH	200		DL	125		DL	75		
			OH	175		OH	325		
Bal.	50		Bal.	200		Bal.	200		

Note: DM = Direct Materials; DL = Direct Labor; OH = Applied Overhead; and Bal. = Balance or Ending Inventory.

3. Work in Process—Bottling 800
   Work in Process—Tableting 800
   To transfer goods to bottling.

When goods are completed in one process, they are transferred with their costs to the subsequent process. For example, mixing transferred $600 of its costs to tableting, and tableting (after further processing) transferred $800 of costs to bottling. A cost transferred from a prior process to a subsequent process is referred to as a **transferred-in cost**. These transferred-in costs are (from the viewpoint of the process receiving them) a type of direct materials cost. This is true because the subsequent process receives a partially completed unit that must be subjected to additional manufacturing activity, which includes more direct labor, more overhead, and, in some cases, additional direct materials. For example, the second journal entry for the tableting department reveals that $400 of additional manufacturing costs were added after receiving the transferred-in goods from mixing. Thus, while mixing sees the active and inert powders as a combination of direct materials, direct labor, and overhead costs, tableting sees only the powder—a direct material, costing $600.

Although a process-costing system has more work-in-process accounts than a job-order costing system, it is a simpler and less expensive system to operate. In a process-costing system, there are no individual jobs, no job-order cost sheets, and no need to track materials to individual jobs. Materials are tracked to processes, but there are far fewer processes than jobs. Further, there is no need to use time tickets for assigning labor costs to processes. Since laborers typically work their entire shift within a particular process, no detailed tracking of labor is needed. In fact, in many firms, labor costs are such a small percentage of total process costs that they are simply combined with overhead costs, creating a conversion cost category.

The Production Report

In process-costing systems, costs are accumulated by department for a period of time. The **production report** is the document that summarizes the manufacturing activity

that takes place in a process department for a given period of time. The production report also serves as a source document for transferring costs from the work-in-process account of a prior department to the work-in-process account of a subsequent department. In the department that handles the final stage of processing, it serves as a source document for transferring costs from the work-in-process account to the finished goods account.

A production report provides information about the physical units processed in a department and also about the manufacturing costs associated with them. Thus, a production report is divided into a unit information section and a cost information section. The unit information section has two major subdivisions: (1) units to account for and (2) units accounted for. Similarly, the cost information section has two major subdivisions: (1) costs to account for and (2) costs accounted for. In summary, a production report traces the flow of units through a department, identifies the costs charged to the department, shows the computation of unit costs, and reveals the disposition of the department's costs for the reporting period.

COST MANAGEMENT **Technology in Action**

Although process-costing systems have less data collection demands than job-order costing systems, they can be very demanding in terms of the calculations required. These calculations, the associated reports, and the detailed tracking of costs from process to process are facilitated by enterprise resource planning (ERP) software. **Fiat Auto Argentina** invested in ERP software to standardize its business processes and to allow access to integrated business information. Fiat implemented **Oracle** ERP software and experienced a 20 percent reduction in internal costs; productivity has improved, and processes have been modernized. Fiat reports that using an Oracle ERP system has produced a reduction in paper flow. Furthermore, an integrated database provides quick access to up-to-date business information critical for decision making.

ERP systems have the capability of linking processes, people, suppliers, and customers. The Oracle sytem has created a single point of contact for servicing its customers, improved relationships with suppliers, and has allowed Fiat to track distributor activities throughout Argentina.

Source : http://success.oracle.com/customers/profiles/PROFILE9033.HTM, accessed August 20, 2004.

Unit Costs

A key input to the cost of production report is unit costs. In principle, calculating unit costs in a process-costing system is very simple. First, measure the manufacturing costs for a process department for a given period of time. Second, measure the output of the process department for the same period of time. Finally, the unit cost for a process is computed by dividing the costs of the period by the output of the period. With the exception of the final process, the unit cost calculated is for a *partially completed unit*. The unit cost for the final process is the cost of the fully completed product. Exhibit 6-4 summarizes the basic features of a process-costing system.

While the basic features seem relatively simple, the actual details of process-costing systems are somewhat more complicated. A major source of difficulty is dealing with how costs and output of the period are defined when calculating the unit cost of each process. The presence of significant work-in-process inventories complicates the cost and output definitions needed for the unit cost calculation. For example, partially finished units in the beginning work-in-process inventory carry with them work and costs associated with a prior period. Yet, these units must be finished this period, and they will also have current-period costs and work associated with them. A fundamental question is how to deal with the prior-period costs and work. Another important and

EXHIBIT 6-4 Basic Features of a Process-Costing System

1. Homogeneous units pass through a series of similar processes.
2. Each unit in each process receives a similar dose of manufacturing costs.
3. Manufacturing costs are accumulated by a process for a given period of time.
4. There is a work-in-process account for each process.
5. Manufacturing cost flows and the associated journal entries are generally similar to job-order costing.
6. The departmental production report is the key document for tracking manufacturing activity and costs.
7. Unit costs are computed by dividing the departmental costs of the period by the output of the period.

related complicating factor is nonuniform application of production costs, i.e., units half completed may not have half of each input needed. Much of our discussion of process-costing systems will deal with the approaches taken to deal with these complicating factors.

OBJECTIVE 2

Describe process costing for settings without work-in-process inventories.

Process Costing with No Work-in-Process Inventories

Perhaps it is best to begin with a discussion of process costing in settings where there are no work-in-process inventories. Seeing how process costing works without work-in-process inventories makes it easier to understand the procedures that are needed to deal with work-in-process inventories. Study of the no-inventory setting is also justified because many firms operate in such a setting.

Service Organizations

Services that are basically homogeneous and repetitively produced can take advantage of a process-costing approach. Processing tax returns, sorting mail by zip code, check processing in a bank, changing oil, air travel between Dallas and New York City, checking baggage, and laundering and pressing shirts are all examples of homogeneous services that are repetitively produced. Although many services consist of a single process, some services require a sequence of processes. Air travel between Dallas and New York City, for example, involves the following sequence of services: reservation, ticketing, baggage checking and seat confirmation, flight, and baggage delivery and pickup. Although services cannot be stored, it is possible for firms engaged in service production to have work-in-process inventories. For example, a batch of tax returns can be partially completed at the end of a period. However, many services are provided in such a way that there are no work-in-process inventories. Teeth cleaning, funerals, surgical operations, sonograms, and carpet cleaning are a few examples where work-in-process inventories would be virtually nonexistent.

To illustrate how services without work-in-process inventories are costed using a process-costing approach, consider the teeth-cleaning process offered by most dentists. This is a single process usually carried out in a room dedicated to the service, with a hygienist (direct labor), materials, and equipment. In this case, the service is labor and overhead intensive. The direct materials used in the process are a small percentage of

the total service cost. The production costs and the number of cleanings (patients served) for the month of March are as follows:

Direct materials	$ 400
Hygienist's salary	3,500
Overhead	2,100
Total production cost	$6,000
Number of cleanings	300

Given the preceding data, the unit cost of the service can be computed as follows:

$$\begin{aligned}\text{Unit cost} &= \text{Costs of the period/Output of the period}\\ &= \$6{,}000/300 \text{ cleanings}\\ &= \$20 \text{ per cleaning}\end{aligned}$$

This calculation illustrates the **process-costing principle**: *To calculate the period's unit cost, divide the costs of the period by the output of the period.* Theoretically, the current-period unit cost should use only costs and output that belong to the period. This principle is a theoretical concept and applies in settings that are more complicated.

JIT Manufacturing Firms

Many firms have adopted a just-in-time (JIT) manufacturing approach.[1] The overall thrust of JIT manufacturing is supplying a product that is needed, when it is needed, and in the quantity that is needed. JIT manufacturing emphasizes continuous improvement and the elimination of waste. Since carrying unnecessary inventory is viewed as wasteful, JIT firms strive to minimize inventories. *Successful* implementation of JIT policies tends to reduce work-in-process inventories to insignificant levels. Furthermore, the way manufacturing is carried out in a JIT firm usually is structured so that process costing can be used to determine product costs. Essentially, work cells are created that produce a product or subassembly from start to finish.

Costs are collected by cell for a period of time, and output for the cell is measured for the same period. Unit costs are computed by dividing the costs of the period by output of the period (following the process-costing principle). The computation is identical to that used by service organizations, as illustrated by the teeth-cleaning example. Why? Because there is no ambiguity concerning what costs belong to the period and how output is measured. One of the objectives of JIT manufacturing is simplification. Keep this in mind as you study the process-costing requirements of manufacturing firms that carry work-in-process inventories. The difference between the two settings is impressive and demonstrates one of the significant benefits of JIT.

The Role of Activity-Based Costing

Activity-based costing can have a role in process settings provided multiple products are being produced. The role of ABC for both cellular and independent process manufacturing is to assign overhead shared by processes or cells to the individual processes and cells. Since each process (cell) is dedicated to the production of a single product, the overhead located within the cell belongs exclusively to the product. However, activities may be shared by processes (cells) such as moving materials, inspecting output, ordering materials, etc. Activity rates are used to assign overhead to individual processes, and this overhead is assigned to process ouput using the usual approaches.

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1. JIT manufacturing and its implications for cost accounting and control are discussed in detail in Chapters 11 and 21.

OBJECTIVE 3

Define *equivalent units*, and explain their role in process costing.

Process Costing with Ending Work-in-Process Inventories

The unit cost is needed both to compute the cost of goods transferred out of a process department and to value ending work-in-process inventories. Work-in-process inventories affect the unit cost computation by affecting the way output of the period is measured. For example, consider a medical laboratory (a service organization) that serves a metropolitan area and several of its outlying communities. The laboratory has several departments, one of which specializes in PSA tests for urologists. Urologists in the region send blood samples to the laboratory. The PSA department runs the test and inputs the resulting data into the computer so that a statistical analysis of the PSA level can be conducted. The PSA levels are also tracked over time for patients who follow a regimen of annual examinations. Printouts are sent to urologists so that they can be placed in the patients' records. During the month of January, 20,000 tests were run and analyzed, and printouts were sent to the referring urologists. These "units" were finished and transferred out by mailing the results of the tests to the urologists. Because of the holiday season, the PSA department rarely has any work in process at the beginning of January. However, at the end of January, there were units (blood samples) that were worked on but not finished, producing an ending work-in-process inventory. By definition, ending work in process is not complete. Thus, a unit completed and transferred out during the period is not identical (or equivalent) to one in ending work-in-process inventory, and the cost attached to the two units should not be the same. In computing the unit cost, the output of the period must be defined. A major problem of process costing is determining this definition.

Equivalent Units as Output Measures

To illustrate the output problem created by work-in-process inventories, assume that the PSA department had the following data for January (output is measured in number of tests):

Units, beginning work in process	—
Units started	24,000
Units completed	20,000
Units, ending work in process (25% complete)	4,000
Total production costs	$168,000

What is the output in January for this department? 20,000 units? 24,000 units? If we say 20,000 units, then we ignore the effort expended on the units in ending work in process. Furthermore, the production costs incurred in January belong to both the units completed and to the partially completed units in ending work in process. On the other hand, if we say 24,000 units, we ignore the fact that the 4,000 units in ending work in process are only partially completed. Somehow, output must be measured so that it reflects the effort expended on both completed and partially completed units.

The solution is to calculate equivalent units of output. **Equivalent units of output** are the complete units that could have been produced given the total amount of productive effort expended for the period under consideration. Determining equivalent units of output for transferred-out units is easy; a unit would not be transferred out unless it were complete. Thus, every transferred-out unit is an equivalent unit. Units remaining in ending work-in-process inventory, however, are not complete. Someone in production must "eyeball" ending work in process to estimate its degree of completion. In the example, the 4,000 units in ending work in process are 25 percent complete with respect to all production costs; this is equivalent to 1,000 fully completed units (4,000 × 25%). Therefore, the equivalent units for January would be the 20,000

completed units plus 1,000 equivalent units in ending work in process, a total of 21,000 units of output.

Cost of Production Report Illustrated

Recall that the cost of production report has a unit information section and a cost information section. The unit information section is concerned with output measurement, and the cost information section is concerned with unit cost computation and cost assignment and reconciliation. The unit information section has two major subdivisions: (1) units to account for and (2) units accounted for. Similarly, the cost information section has two major subdivisions: (1) costs to account for and (2) costs accounted for. A cost of production report for the PSA department example is illustrated in Exhibit 6-5.

EXHIBIT 6-5 PSA Department Production Report for January

Unit Information

Units to account for:		
Units in beginning work in process	0	
Units started	24,000	
Total units to account for	24,000	
	Physical Flow	*Equivalent Units*
Units accounted for:		
Units completed	20,000	20,000
Units in ending work in process (25% complete)	4,000	1,000
Units accounted for	24,000	
Work completed		21,000

Cost Information

Costs to account for:	
Beginning work in process	$ 0
Incurred during the period	168,000
Total costs to account for	$168,000
Divided by equivalent units	÷ 21,000
Cost per equivalent unit	$ 8
Costs accounted for:	
Goods transferred out ($8 × 20,000)	$160,000
Ending work in process ($8 × 1,000)	8,000
Total costs accounted for	$168,000

The computations in Exhibit 6-5 illustrate several important points. Knowing the output for a period (equivalent work completed of 21,000 units) and the production costs for the department for that period ($168,000 in this example), we can calculate a unit cost, which in this case is $8 per unit ($168,000/21,000). The unit cost is used to assign a cost of $160,000 ($8 × 20,000) to the 20,000 units transferred out and a

cost of $8,000 ($8 × 1,000) to the 4,000 units in ending work in process. This unit cost is $8 per *equivalent* unit. Thus, when valuing ending work in process, the $8 unit cost is multiplied by the equivalent units, not the actual number of physical units in process.

Five steps must be followed in preparing a cost of production report:

1. Analysis of the flow of physical units
2. Calculation of equivalent units
3. Computation of unit cost
4. Valuation of inventories (goods transferred out and ending work in process)
5. Cost reconciliation

Knowing the physical units in beginning and ending work in process, their stage of completion, and the units completed and transferred out (step 1) provides essential information for the computation of equivalent units (step 2). This computation, in turn, is a prerequisite to computing the unit cost (step 3). Unit cost information and information from the equivalent units schedule are both needed to value goods transferred out and goods in ending work in process (step 4). Finally, the costs in beginning work in process and the costs incurred during the current period should equal the total costs assigned to goods transferred out and to goods in ending work in process (step 5). Step 5 (**cost reconciliation**), of course, is simply a check on the accuracy of the report itself.

Nonuniform Application of Productive Inputs

Up to this point, we have assumed that work in process being 25 percent complete meant that 25 percent of direct materials, direct labor, and overhead needed to complete the process have been used and that another 75 percent are needed to finish the units. In other words, we have assumed that the productive inputs are applied uniformly as the manufacturing process unfolds.

Assuming uniform application of conversion costs (direct labor and overhead) is not unreasonable. Direct labor input is usually needed throughout the process, and overhead is normally assigned on the basis of direct labor hours. Direct materials, on the other hand, are not as likely to be applied uniformly. In many instances, direct materials are added at either the beginning or the end of the process.

For example, consider the PSA department in Exhibit 6-5. It is more likely that materials (e.g., special chemicals) would be added at the beginning of the process rather than uniformly throughout the process. If so, then ending work in process that is 25 percent complete with respect to conversion inputs would be 100 percent complete with respect to material inputs.

Different percentage completion figures for productive inputs at the same stage of completion pose a problem for the calculation of equivalent units. Fortunately, the solution is relatively simple. Equivalent units calculations are done for each category of input. Thus, there are equivalent units calculated for *each* category of direct materials and for conversion costs. For the PSA department, if direct materials are added at the beginning of the process, equivalent units of work for each category would be calculated as follows:

	Direct Materials	*Conversion Costs*
Units completed	20,000	20,000
Units, ending work in process:		
4,000 × 100%	4,000	
4,000 × 25%		1,000
Equivalent units of output	24,000	21,000

Of course, having separate categories of equivalent units requires that the costs of each category be measured separately. Unit costs are then calculated for each input category, and the total unit cost is the sum of the individual category unit costs. For example, the following cost breakdown would produce the indicated unit costs:

	Direct Materials	*Conversion*	*Total*
Total cost	$126,000	$42,000	$168,000
Equivalent units	24,000	21,000	—
Unit cost	$5.25	$2.00	$7.25

Beginning Work-in-Process Inventories

The PSA department example only showed the effect of ending work-in-process inventories on output measurement. The presence of beginning work-in-process inventories also complicates output measurement. Since many firms have partially completed units in process at the beginning of a period, there is a clear need to address the issue. The work done on these partially completed units represents prior-period work, and the costs assigned to them are prior-period costs. In computing a *current-period* unit cost for a department, two approaches have evolved for dealing with the prior-period output and prior-period costs found in beginning work in process: the *first-in, first-out (FIFO) costing method* and the *weighted average method*. Both methods follow the same five steps described for preparing a cost of production report. However, the two methods usually only produce the same result for step 1. The two methods are best illustrated by example. The FIFO method is discussed first, followed by a discussion of the weighted average method.

FIFO Costing Method

OBJECTIVE 4

Prepare a departmental production report using the FIFO method.

The process-costing principle requires that the costs of the period be divided by the output of the period. Thus, theoretically, only *current*-period costs and *current*-period output should be used to compute *current*-period unit costs. The FIFO method attempts to follow this theoretical guideline. Under the **FIFO costing method**, the equivalent units and manufacturing costs in beginning work in process are *excluded* from the current-period unit cost calculation. Thus, the FIFO method recognizes that the work and costs carried over from the prior period legitimately belong to that period.

Since FIFO excludes prior-period work and costs, we need to create two categories of completed units. FIFO assumes that units in beginning work in process are completed first, before any new units are started. Thus, one category of completed units is that of beginning work-in-process units. The second category is for those units started *and* completed during the current period.

These two categories of completed units are needed in the FIFO method so that each category can be costed correctly. For the units started and completed, the unit cost is obtained by dividing total current manufacturing costs by the current-period equivalent output. However, for the beginning work-in-process units, the total associated manufacturing costs are the sum of the prior-period costs plus the costs incurred in the current period to finish the units. Thus, the unit cost is this total cost divided by the units in beginning work in process.

To illustrate the FIFO method, let's return to Estrella Company, a company that mass produces a widely used pain medication (see discussion on pp. 227–229). Recall that this company uses three processes: mixing, tableting, and bottling. October's cost and production data for the mixing department are given in Exhibit 6-6. All materials are added at the beginning of the mixing process. Output is measured in ounces. Given the October data for Estrella, the five steps of the FIFO method can be illustrated.

EXHIBIT 6-6 Estrella Company Mixing Department Production and Cost Data: October

Production:	
Units in process, October 1, 70% complete*	10,000
Units completed and transferred out	60,000
Units in process, October 31, 40% complete*	20,000
Costs:	
Work in process, October 1:	
Direct materials	$ 1,000
Conversion costs	350
Total work in process	$ 1,350
Current costs:	
Direct materials	$12,600
Conversion costs	3,050
Total current costs	$15,650

*With respect to conversion cost. Direct materials are 100 percent complete because they are added at the beginning of the process.

Step 1: Physical Flow Analysis

The purpose of step 1 is to trace the physical units of production. Physical units are *not* equivalent units; they are units that may be in any stage of completion. The data reveal that there are 80,000 physical units (ounces) to account for. In this example, 10,000 units are from beginning inventory. Another 70,000 units were started in October. Finally, 20,000 units remain in ending inventory, 40 percent complete. The analysis of physical flow of units is usually accomplished by preparing a **physical flow schedule** similar to the one shown in Exhibit 6-7.

To construct the schedule from the information given in the example, two calculations are needed. First, units started and completed in this period are obtained by subtracting the units in beginning work in process from the total units completed. Next,

EXHIBIT 6-7 Physical Flow Schedule: Mixing Department

Units to account for:		
Units, beginning work in process		10,000
Units started during October		70,000
Total units to account for		80,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	50,000	
From beginning work in process	10,000	60,000
Units in ending work in process (40% complete)		20,000
Total units accounted for		80,000

the units started are obtained by adding the units started and completed to the units in ending work in process. Notice that the "total units to account for" must equal the "total units accounted for." The physical flow schedule in Exhibit 6-7 is important because it contains the information needed to calculate equivalent units (step 2).

Step 2: Calculation of Equivalent Units

Exhibit 6-8 illustrates the calculation of equivalent units under the FIFO method. Notice that the equivalent units in beginning work in process—work done in the prior period—are not counted as part of the total equivalent work (work means either adding direct materials or conversion activity). Only the equivalent work to be completed this period is counted. The equivalent work to be completed for the units from the prior period is computed by multiplying the number of units in beginning work in process by the percentage of work remaining. Since in this example the direct materials are added at the beginning of the process, no additional direct materials are needed. However, the units are only 70 percent complete with respect to conversion activity. Thus, 30 percent additional conversion activity is needed, which converts to 3,000 additional equivalent units of work (30% × 10,000).

EXHIBIT 6-8 Equivalent Units of Production: FIFO Method

	Direct Materials	Conversion Costs
Units started and completed	50,000	50,000
Add: Units in beginning work in process × Percentage to complete:		
10,000 × 0% direct materials	—	
10,000 × 30% conversion costs		3,000
Add: Units in ending work in process × Percentage complete:		
20,000 × 100% direct materials	20,000	—
20,000 × 40% conversion costs	—	8,000
Equivalent units of output	70,000	61,000

Step 3: Computation of Unit Cost

The computation of the unit cost relies only on current costs and current output. The calculation is as follows:

$$\begin{aligned}\text{Unit direct materials cost} &= \$12{,}600/70{,}000 = \$0.18\\ \text{Unit conversion costs} &= \$3{,}050/61{,}000 = \$0.05\\ \text{Unit cost} &= \text{Unit direct materials cost} + \text{Unit conversion costs}\\ &= \$0.18 + \$0.05\\ &= \$0.23 \text{ per ounce}\end{aligned}$$

Step 4: Valuation of Inventories

The FIFO method unit costs are used to value output that is related to the *current period*. There are three categories of current-period output: equivalent units in ending work in process, units started and completed, and the equivalent units of work necessary to *finish* the units in beginning work in process.

Since all equivalent units in ending work in process are current-period units (see Exhibit 6-8), the cost of ending work in process is computed as follows:

Cost of ending work in process:	
Direct materials ($0.18 × 20,000)	$3,600
Conversion costs ($0.05 × 8,000)	400
Total	$4,000

When it comes to valuing goods transferred out, two categories of completed units must be considered: those that were started and completed and those that were completed from beginning work in process. Of the 60,000 completed units, 50,000 are units started and completed in the current period, and 10,000 are units completed from beginning work in process (see Exhibit 6-7). The 50,000 units that were started and completed in the current period represent current output and are valued at $0.23 per unit. For these units, the use of the current-period unit cost is entirely appropriate. However, the cost of the 10,000 beginning work-in-process units that were transferred out is another matter. These units started the period with $1,350 of manufacturing costs already incurred (cost taken from Exhibit 6-6), 10,000 equivalent units of direct materials already added, and 7,000 equivalent units of conversion activity already completed. To these beginning costs, additional costs were needed to finish the units. As we saw in step 2, the effort expended to complete these units required an additional 3,000 equivalent units of conversion activity. These 3,000 equivalent units of conversion activity were produced this period at a cost of $0.05 per equivalent unit. Thus, the total cost of finishing the units in beginning work in process is $150 ($0.05 × 3,000). Adding this $150 to the $1,350 in cost carried over from the prior period gives a total manufacturing cost for these units of $1,500. The total cost of goods transferred out can be summarized as follows:

Units started and completed ($0.23 × 50,000)		$11,500
Units, beginning work in process:		
Prior-period costs	$1,350	
Costs to finish ($0.05 × 3,000)	150	1,500
Total		$13,000

Step 5: Cost Reconciliation

Manufacturing costs are reconciled as follows:

Costs to account for:		
Beginning work in process		$ 1,350
Incurred during the period:		
Direct materials	$12,600	
Conversion costs	3,050	15,650
Total costs to account for		$17,000
Costs accounted for:		
Goods transferred out:		
Units, beginning work in process		$ 1,500
Units started and completed		11,500
Goods in ending work in process		4,000
Total costs accounted for		$17,000

The cost of production report for the FIFO method is given in Exhibit 6-9.

EXHIBIT 6-9 Production Report: Mixing Department

Estrella Company
Mixing Department
Production Report for October
(FIFO Method)

Unit Information

Units to account for:		Units accounted for:	
Units, beginning work in process	10,000	Units completed	60,000
Units started	70,000	Units, ending work in process	20,000
Total units to account for	80,000	Total units accounted for	80,000

	Equivalent Units	
	Direct Materials	*Conversion Costs*
Units started and completed	50,000	50,000
Units, beginning work in process	—	3,000
Units, ending work in process	20,000	8,000
Equivalent units of output	70,000	61,000

Cost Information

Costs to account for:

	Direct Materials	*Conversion Costs*	*Total*
Beginning work in process	$ 1,000	$ 350	$ 1,350
Incurred during the period	12,600	3,050	15,650
Total costs to account for	$13,600	$ 3,400	$17,000
Cost per equivalent unit:			
Current costs	$12,600	$ 3,050	
Divided by equivalent units	÷70,000	÷61,000	
Cost per equivalent unit	$ 0.18	$ 0.05	$ 0.23

Costs accounted for:		
Units transferred out:		
Units, beginning work in process:		
From prior period	$ 1,350	
From current period ($0.05 × 3,000)	150	
Units started and completed ($0.23 × 50,000)	11,500	$13,000
Ending work in process:		
Direct materials (20,000 × $0.18)	$ 3,600	
Conversion costs (8,000 × $0.05)	400	4,000
Total costs accounted for		$17,000

Journal Entries

The journal entries associated with the mixing department's activities for October are as follows:

1.	Work in Process—Mixing	12,600	
	Materials		12,600
	To record requisitions of materials for October.		
2.	Work in Process—Mixing	3,050	
	Conversion Cost Control		3,050
	To record the application of overhead and the incurrence of direct labor.		
3.	Work in Process—Tableting	13,000	
	Work in Process—Mixing		13,000
	To record the transfer of cost of goods completed from mixing to tableting.		

OBJECTIVE 5

Prepare a departmental production report using the weighted average method.

Weighted Average Costing Method

Excluding prior-period work and costs creates some bookkeeping and computational complexity that can be avoided if certain conditions are satisfied. Specifically, if the costs of production remain very stable from one period to the next, then it may be possible to use the weighted average method. This method does not track prior-period output and costs separately from current-period output and costs. The **weighted average costing method** picks up beginning inventory costs and the accompanying equivalent output and treats them as if they belong to the current period. Prior-period output and manufacturing costs found in beginning work in process are merged with the current-period output and manufacturing costs.

The merging of beginning inventory output and current-period output is accomplished by the way in which equivalent units are calculated. Under the weighted average method, equivalent units of output are computed by adding units completed to equivalent units in ending work in process. The equivalent units in beginning work in process are included in the computation. Thus, these units are counted as part of the current period's equivalent units of output.

The weighted average method merges prior-period costs with current-period costs by simply adding the manufacturing costs in beginning work in process to the manufacturing costs incurred during the current period. The total cost is treated as if it were the current period's total manufacturing cost.

The illustration of the weighted average method is based on the Estrella Company data found in Exhibit 6-6 on page 237. Using the same data highlights the differences between the two methods. The five steps for costing out production follow.

Step 1: Physical Flow Analysis

The purpose of step 1 is to trace the physical units of production. This is accomplished by preparing a physical flow schedule. This schedule, shown in Exhibit 6-10, is identical for both methods.

Step 2: Calculation of Equivalent Units

Given the information in the physical flow schedule, the weighted average equivalent units for October can be calculated. This calculation is shown in Exhibit 6-11.

Notice that October's output is measured as 80,000 units for direct materials and 68,000 units for conversion activity. The 10,000 equivalent units of direct materials (10,000 × 100%) found in beginning work in process are included in the 60,000 units

EXHIBIT 6-10 Physical Flow Schedule: Mixing Department

Units to account for:		
Units, beginning work in process		10,000
Units started during October		70,000
Total units to account for		80,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	50,000	
From beginning work in process	10,000	60,000
Units, ending work in process (40% complete)		20,000
Total units accounted for		80,000

EXHIBIT 6-11 Equivalent Units of Production: Weighted Average Method

	Direct Materials	Conversion Costs
Units completed	60,000	60,000
Add: Units in ending work in process × Percentage complete:		
20,000 × 100%	20,000	—
20,000 × 40%	—	8,000
Equivalent units of output	80,000	68,000

completed. Similarly, the 7,000 equivalent units of conversion costs (70% × 10,000) found in beginning work in process are also included in the 60,000 units completed for the conversion category.[2] Thus, beginning inventory units are treated as if they were started and completed during the current period.

Step 3: Computation of Unit Cost

In addition to the period's equivalent units, the period's direct materials cost and conversion costs are needed to compute a unit cost. The weighted average method merges current manufacturing costs and the manufacturing costs associated with the units in beginning work in process. Thus, the total direct materials cost for October is defined as $13,600 ($1,000 + $12,600), and the total conversion costs are defined as $3,400 ($350 + $3,050).

When different categories of equivalent units exist, a unit cost for each category must be computed. The cost per completed unit is the sum of these individual unit costs. The computations are as follows:

2. You should note that if we subtract the 10,000 equivalent units of direct material from the 80,000 units computed by the weighted average method, we arrive at the 70,000 units computed by the FIFO method; similarly, if we subtract out the 7,000 equivalent units from the 68,000 conversion costs equivalent units computed by the weighted average method, we obtain the 61,000 units computed by the FIFO method. This illustrates the point that the weighted average method counts prior-period output in the measurement of output for the current period.

$$\begin{aligned}\text{Unit direct materials cost} &= (\$1{,}000 + \$12{,}600)/80{,}000\\ &= \$0.17\\ \text{Unit conversion costs} &= (\$350 + \$3{,}050)/68{,}000\\ &= \$0.05\\ \text{Total unit cost} &= \text{Unit direct materials cost} + \text{Unit conversion costs}\\ &= \$0.17 + \$0.05\\ &= \$0.22 \text{ per completed unit}\end{aligned}$$

Step 4: Valuation of Inventories

Valuation of goods transferred out (step 4) is accomplished by multiplying the unit cost by the goods completed.

$$\begin{aligned}\text{Cost of goods transferred out} &= \$0.22 \times 60{,}000\\ &= \$13{,}200\end{aligned}$$

Costing out ending work in process is done by obtaining the cost of each manufacturing input and then adding these individual input costs. For our example, this requires adding the cost of the direct materials in ending work in process to the conversion costs in ending work in process.

The cost of direct materials is the unit direct materials costs multiplied by the direct materials equivalent units in ending work in process. Similarly, the total conversion costs in ending work in process is the unit conversion costs times the conversion costs equivalent units. Thus, the cost of ending work in process is calculated as follows:

Direct materials: $0.17 × 20,000	$3,400
Conversion costs: $0.05 × 8,000	400
Total cost	$3,800

Step 5: Cost Reconciliation

The total manufacturing costs are accounted for as follows:

Costs to account for:	
Beginning work in process	$ 1,350
Incurred during the period	15,650
Total costs to account for	$17,000
Costs accounted for:	
Goods transferred out	$13,200
Ending work in process	3,800
Total costs accounted for	$17,000

Production Report

Steps 1 through 5 provide all of the information needed to prepare a production report for the mixing department for October. This report is given in Exhibit 6-12 on page 244. The journal entries for the weighted average method follow the same pattern shown for the FIFO method. Thus, there is no reason to repeat the entries.

FIFO Compared with Weighted Average

The FIFO and weighted average methods differ on two key dimensions: (1) how output is computed and (2) what costs are used for calculating the period's unit cost. The unit cost computation for the mixing department is as follows:

EXHIBIT 6-12 Production Report: Mixing Department

Estrella Company
Mixing Department
Production Report for October
(Weighted Average Method)

Unit Information

Units to account for:		Units accounted for:	
Units, beginning work in process	10,000	Units completed	60,000
Units started	70,000	Units, ending work in process	20,000
Total units to account for	80,000	Total units accounted for	80,000

	Equivalent Units	
	Direct Materials	*Conversion Costs*
Units completed	60,000	60,000
Units, ending work in process	20,000	8,000
Equivalent units of output	80,000	68,000

Cost Information

Costs to account for:

	Direct Materials	*Conversion Costs*	*Total*
Beginning work in process	$ 1,000	$ 350	$ 1,350
Incurred during the period	12,600	3,050	15,650
Total costs to account for	$13,600	$ 3,400	$17,000
Divided by equivalent units	÷80,000	÷68,000	
Cost per equivalent unit	$ 0.17	$ 0.05	$ 0.22

Costs accounted for:		
Units transferred out (60,000 × $0.22)		$13,200
Ending work in process:		
Direct materials (20,000 × $0.17)	$ 3,400	
Conversion costs (8,000 × $0.05)	400	3,800
Total costs accounted for		$17,000

	FIFO		Weighted Average	
	Direct Materials	*Conversion Costs*	*Direct Materials*	*Conversion Costs*
Costs	$12,600	$3,050	$13,600	$3,400
Output (units)	70,000	61,000	80,000	68,000
Unit cost	$0.18	$0.05	$0.17	$0.05

The two methods use different total costs and different measures of output. The FIFO method is the more theoretically appealing because it divides the cost of the period by

the output of the period. The weighted average method, however, merges costs in beginning work in process with current-period costs and merges the output found in beginning work in process with current-period output. This creates the possibility for errors—particularly if the weighted average method is used for settings where input costs are changing significantly from one period to the next.

In the mixing department example, the FIFO method unit cost and the weighted average method unit cost for conversion costs are the same; evidently, the cost of this input remained the same for the two periods being considered. The unit direct materials cost for the FIFO method, however, is $0.18 versus $0.17 for the weighted average method. Apparently, the cost of direct materials has increased, and merging the lower direct materials cost of the prior period with that of the current period creates a weighted average direct materials cost that underestimates the current-period direct materials cost. The resulting difference in the cost of a fully completed unit is only $0.01 ($0.23 − $0.22). On the surface, this seems harmless.

The difference in the costs reported under each method for goods transferred out and the ending work-in-process inventories is only $200 (see Exhibits 6-9 and 6-12). This is less than a 2 percent difference for goods transferred out and only about a 5 percent difference for ending work in process. The $0.01 unit cost difference does not appear to be material. Yet, if the final product is considered, even a $0.01 difference may be significant. Recall that Estrella passes the powder from the mixing department to the tableting department, where the powder is converted to caplets. Next, the caplets are sent to the bottling department where eight tablets are placed in small metal boxes. The output of the mixing department is measured in ounces. Suppose that four ounces of powder convert to eight tablets. The difference in the cost of the final product would be understated by $0.04—not $0.01. Using this unit cost information may produce erroneous decisions such as under- or overpricing. Furthermore, if the other two departments also use the weighted average method, the costs in those departments could also be understated. The cumulative effect could produce a significant distortion in cost for the final product—magnifying the effect.

A second disadvantage of weighted average costing should be mentioned as well. The weighted average method also combines the performance of the current period with that of a prior period. Often, it is desirable to exercise control by comparing the actual costs of the current period with the budgeted or standard costs for the period. The weighted average method makes this comparison suspect because the performance of the current period is not independent of the prior period.

The major benefit of the weighted average method is simplicity. By treating units in beginning work in process as belonging to the current period, all equivalent units belong to the same time period when it comes to calculating unit costs. As a consequence, the requirements for computing unit cost are greatly simplified. Yet, as has been discussed, accuracy and performance measurement are impaired. The FIFO method overcomes both of these disadvantages. It should be mentioned, however, that both methods are widely used. Perhaps we can conclude that there are many settings in which the distortions caused by the weighted average method are not serious enough to be of concern.

OBJECTIVE 6

Prepare a departmental production report with transferred-in goods and changes in output measures.

Treatment of Transferred-In Goods

In process manufacturing, some departments invariably receive partially completed goods from prior departments. For example, under the FIFO method, the transfer of goods from mixing to tableting is valued at $13,000. These transferred-in goods are a type of direct material for the subsequent process—materials that are added at the beginning of the subsequent process. The usual approach is to treat transferred-in goods as a separate material category when calculating equivalent units. Thus, we now have three categories of manufacturing inputs: transferred-in materials, direct materials added,

and conversion costs. For the Estrella Company example, tableting receives transferred-in materials, a powdered mixture, from mixing; adds a binder and coating (direct materials); and uses labor and overhead to convert the powder into tablets.

In dealing with transferred-in goods, three important points should be remembered. First, the cost of this material is the cost of the goods transferred out computed in the prior department. Second, the units started in the subsequent department correspond to the units transferred out from the prior department, assuming that there is a one-to-one relationship between the output measures of both departments. Third, the units of the transferring department may be measured differently than the units of the receiving department. If this is the case, then the goods transferred in must be converted to the units of measure used by the second department.

To illustrate how process costing works for a department that receives transferred-in work, we will use the tableting department of the Estrella Company. The tableting department receives a powder from mixing, adds a binder, presses the powder into caplet shapes, and then coats the tablets. The units of the mixing department are measured in ounces, and the units of the tableting department are measured in tablets. To convert ounces to tablets, we need to know the relationship between ounces and tablets. The binding agent is added at the beginning of the process and increases the ounces of material by 10 percent. Every ounce of this new mix then converts to four tablets. Thus, to convert the transferred-in material to the new output measure, we must first multiply by 1.1 and then multiply by four, or equivalently, we must multiply the transferred-in units by 4.4.

Now let's consider the month of October for Estrella Company and focus our attention on the tableting department. We will assume that Estrella Company uses the weighted average method. October's cost and production data for the tableting department are given in Exhibit 6-13. Notice that the transferred-in cost for October is the mixing department's transferred-out cost. (Exhibit 6-12 shows that the mixing department transferred out 60,000 ounces of powder, costing $13,200.) Also notice that output for the tableting department is measured in tablets. Given the data in Exhibit 6-13, the five steps of process costing can be illustrated for the tableting department.

EXHIBIT 6-13 **Estrella Company Tableting Department**
Production and Cost Data: October

Production:	
Units in process, October 1, 80% complete[a]	16,000 (tablets)
Units completed and transferred out	250,000
Units in process, October 31, 30% complete[a]	30,000
Costs:	
Work in process, October 1:	
Transferred-in cost	$ 800
Direct materials (binding agent)[b]	300
Conversion costs	180
Total work in process	$ 1,280
Current costs:	
Transferred-in costs	$13,200
Direct materials (binding agent)[b]	2,500
Conversion costs	5,000
Total current costs	$20,700

[a]With respect to conversion costs. Direct materials are 100 percent complete because they are added at the beginning of the process.
[b]The cost of tablet coating materials is insignificant and therefore added to the conversion costs category.

Step 1: Physical Flow Schedule

In constructing a physical flow schedule for the tableting department, its dependence on the mixing department must be considered:

Units to account for:		
Units, beginning work in process		16,000
Units transferred in during October		264,000*
Total units to account for		280,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	234,000	
From beginning work in process	16,000	250,000
Units, ending work in process		30,000
Total units accounted for		280,000

*60,000 × 4.4 (converts transferred-in units from ounces to tablets)

Step 2: Calculation of Equivalent Units

The calculation of equivalent units of production using the weighted average method is shown in Exhibit 6-14. Notice that the transferred-in goods from mixing are treated as materials added at the beginning of the process. Transferred-in materials are always 100 percent complete, since they are added at the beginning of the process.

EXHIBIT 6-14 Equivalent Units of Production: Weighted Average Method

	Transferred-In Materials	Direct Materials Added	Conversion Costs
Units completed	250,000	250,000	250,000
Add: Units in ending work in process × Percentage complete:			
30,000 × 100%	30,000	—	—
30,000 × 100%	—	30,000	—
30,000 × 30%	—	—	9,000
Equivalent units of output	280,000	280,000	259,000

Step 3: Computation of Unit Costs

The unit cost is computed by calculating the unit cost for each input category:

$$\begin{aligned}\text{Unit transferred-in cost} &= (\$800 + \$13{,}200)/280{,}000 = \$0.05\\ \text{Unit direct materials cost} &= (\$300 + \$2{,}500)/280{,}000 = \$0.01\\ \text{Unit conversion costs} &= (\$180 + \$5{,}000)/259{,}000 = \$0.02\\ \text{Total unit cost} &= \$0.05 + \$0.01 + \$0.02\\ &= \$0.08\end{aligned}$$

Step 4: Valuation of Inventories

The cost of goods transferred out is simply the unit cost multiplied by the goods completed:

$$\text{Cost of goods transferred out} = \$0.08 \times 250{,}000 = \$20{,}000$$

Costing out ending work in process is done by computing the cost of each input and then adding to obtain the total:

Transferred-in materials: $0.05 × 30,000	$1,500
Direct materials added: $0.01 × 30,000	300
Conversion costs: $0.02 × 9,000	180
Total	$1,980

The cost of production report for Estrella Company for the month of October, including Step 5 (which was skipped), is shown in Exhibit 6-15.

EXHIBIT 6-15 Production Report: Tableting Department

Estrella Company
Tableting Department
Production Report for October
(Weighted Average Method)

Unit Information

Units to account for:		Units accounted for:	
Units, beginning work in process	16,000	Units completed	250,000
Units started	264,000	Units, ending work in process	30,000
Total units to account for	280,000	Total units accounted for	280,000

	Equivalent Units		
	Transferred-In Materials	*Direct Materials*	*Conversion Costs*
Units completed	250,000	250,000	250,000
Units, ending work in process	30,000	30,000	9,000
Total equivalent units	280,000	280,000	259,000

Cost Information

Costs to account for:

	Transferred-In Materials	*Direct Materials*	*Conversion Costs*	*Total*
Beginning work in process	$ 800	$ 300	$ 180	$ 1,280
Incurred during the period	13,200	2,500	5,000	20,700
Total costs to account for	$ 14,000	$ 2,800	$ 5,180	$21,980
Divided by equivalent units	÷280,000	÷280,000	÷259,000	
Cost per equivalent unit	$ 0.05	$ 0.01	$ 0.02	$ 0.08

Costs accounted for:			
Units transferred out (250,000 × $0.08)			$20,000
Ending work in process:			
Transferred-in materials ($0.05 × 30,000)		$1,500	
Direct materials (30,000 × $0.01)		300	
Conversion costs (9,000 × $0.02)		180	1,980
Total costs accounted for			$21,980

The only additional complication introduced in the analysis for a subsequent department is the presence of the transferred-in category. As we have just shown, dealing with this category is similar to handling any other category. However, remember that the current cost of this special type of material is the cost of the units transferred in from the prior process and that the units transferred in are the units started (adjusted for any differences in output measurement).

OBJECTIVE 7

Describe the basic features of operation costing.

Operation Costing

Not all manufacturing firms have a pure job production environment or a pure process production environment. Some manufacturing firms have characteristics of both job and process environments. Firms in these *hybrid* settings often use *batch production processes*. **Batch production processes** produce batches of different products which are identical in many ways but differ in others. In particular, many firms produce products that make virtually the same demands on conversion inputs but different demands on direct materials inputs. Thus, the conversion activities are similar or identical, but the direct materials used are significantly different. For example, the conversion activities required to produce cans of pie filling are essentially identical for apple or cherry pie filling, but the cost of the direct materials can differ significantly. Similarly, the conversion activities for women's skirts may be identical, but the cost of direct materials can differ dramatically, depending on the nature of the fabric used (wool versus polyester, for example). Clothes, textiles, shoes, and food industries are examples where batch production may take place. For these firms, a costing system known as *operation costing* is often adopted.

Basics of Operation Costing

Operation costing is a blend of job-order and process-costing procedures applied to batches of homogeneous products. This costing system uses *job-order procedures* to assign direct materials costs to batches and *process procedures* to assign conversion costs. A hybrid costing approach is used because each batch uses different doses of direct materials but makes the same demands on the conversion resources of individual processes (usually called operations). Although different batches may pass through different operations, the demands for conversion activities for the *same* process do not differ among batches.

Work orders are used to collect production costs for each batch. Work orders also are used to initiate production. Using work orders to initiate and track costs to each batch is a job-costing characteristic. However, since individual products of different batches consume the same conversion resources as they pass through the same operation, then each product (regardless of batch membership) can be treated as a single homogeneous unit. This last trait is a process-costing characteristic and can be exploited to simplify the assignment of conversion costs.

Materials requisition forms are used to identify the direct materials, quantity and prices, and work order number. Using the materials requisition form as the source document, the cost of direct materials is posted to the work order sheet. Conversion costs are collected by *process* and assigned to products using a *predetermined conversion rate* (identical in concept to predetermined overhead rates). Conversion costs are budgeted for each department, and a single conversion rate is computed for each department (process) using a unit-based activity driver such as direct labor hours or machine hours. For example, assume that the budgeted conversion costs for a sewing operation are $100,000 (consisting of items such as direct labor, depreciation, supplies, and power), and the practical capacity of the operation is 10,000 machine hours. The conversion rate is computed as follows:

$$\text{Conversion rate} = \$100{,}000/10{,}000 \text{ machine hours} = \$10 \text{ per machine hour}$$

Now consider two batches of shoes that pass through the sewing operation: one batch consists of 50 pairs of men's leather boots, and the second batch consists of 50 pairs of women's leather sandals. First, it should be clear that the batches have different direct material requirements so the cost of direct materials should be tracked separately (job-costing feature). Second, it should also be obvious that the sewing activity is the same for each in the sense that one hour of sewing time should consume the same resources regardless of whether the product is boots or sandals (the process-costing feature). If the batch of boots takes 25 machine hours, the batch will be assigned $250 of conversion costs ($10 × 25 hours). If the batch of sandals takes 12 machine hours, it will be assigned $120 of conversion costs ($10 × 12). Again, even though the products consume the same resources per machine hour, the batches can differ in total amount of resources consumed in an operation. So it is necessary to use a work order for each batch to collect costs.

Exhibit 6-16 illustrates the physical flow and cost flow features of operation costing. The illustration is for two batches and three processes. Panel A illustrates the physical flows, and Panel B shows the cost flows. The letters *a* and *f* represent the assignment of direct materials cost to the two batches. This example assumes that all direct materials are issued at the very beginning. Thus, direct materials cost would be assigned to the work-in-process account for the beginning process for each batch. The example also illustrates that batches do not have to participate in every process. Batch A uses Processes 2 and 3, while Batch B uses Processes 1 and 2. The letters immediately following the process represent the application of conversion costs to the respective batches.

Operation Costing Example

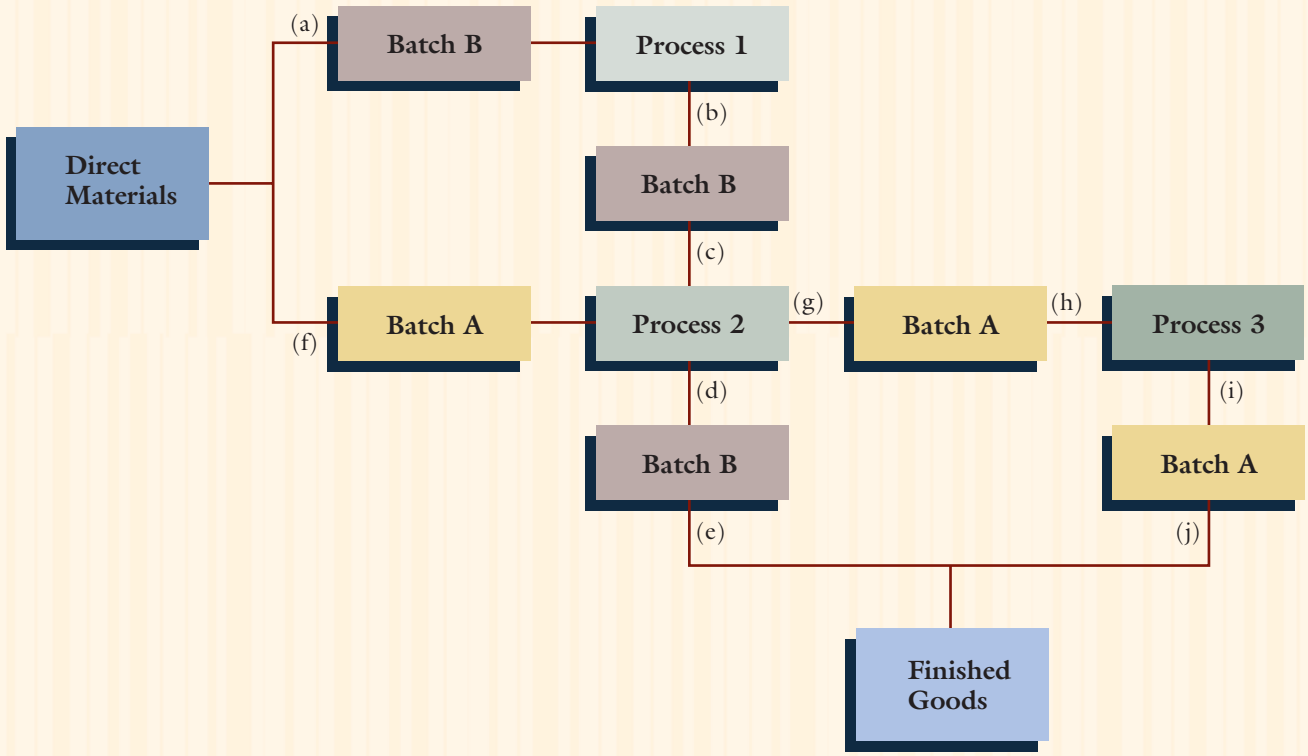
To illustrate operation costing, consider a company that produces a variety of vitamin and mineral products. The company produces a multivitamin and mineral product as well as single vitamin and mineral products, e.g., bottles of vitamins C and E, calcium, etc. Assume that the company also produces different strengths of vitamins (for example, 200 mg and 1,000 mg doses of vitamin C). The company also uses different sizes of bottles (for example, 60 and 120 capsules). There are four operations: picking, encapsulating, tableting, and bottling. Consider the following two work orders:

	Work Order 100	*Work Order 101*
Direct materials	Ascorbic acid	Vitamin E
	Capsules	Vitamin C
	Bottle (100 capsules)	Vitamin B-1
	Cap and labels	Vitamin B-2
		Vitamin B-4
		Vitamin B-12
		Biotin
		Zinc
		Bottle (60 tablets)
		Cap and labels
Operations	Picking	Picking
	Encapsulating	Tableting
	Bottling	Bottling
Number in batch	5,000 bottles	10,000 bottles

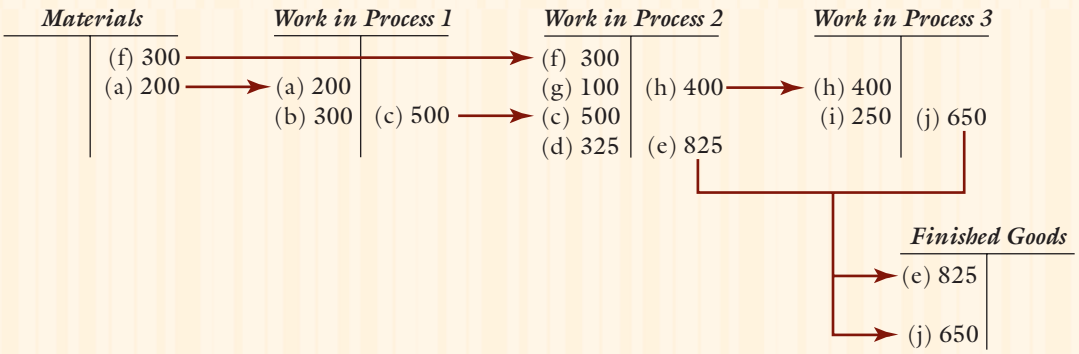
Notice how the work order specifies the direct materials needed, the operation required, and the size of the batch. Assume the following costs are collected by work order:

EXHIBIT 6-16 Basic Features of Operation Costing

Panel A: Physical Flows



Panel B: Cost Flows (shown by letter in Panel A and in dollars below)



	Work Order 100	*Work Order 101*
Direct materials	$4,000	$15,000
Conversion costs:		
Picking	1,000	3,000
Encapsulating	3,000	—
Tableting	—	4,000
Bottling	1,500	2,000
Total production costs	$9,500	$24,000

The journal entries associated with Work Order 100 follow. The first entry assumes that all materials needed for the batch are requisitioned at the start. Another possibility is to requisition the materials needed for the batch in each process as the batch enters that process.

1.	Work in Process—Picking	4,000	
	Materials		4,000
2.	Work in Process—Picking	1,000	
	Conversion Costs Applied		1,000
3.	Work in Process—Encapsulating	5,000	
	Work in Process—Picking		5,000
4.	Work in Process—Encapsulating	3,000	
	Conversion Costs Applied		3,000
5.	Work in Process—Bottling	8,000	
	Work in Process—Encapsulating		8,000
6.	Work in Process—Bottling	1,500	
	Conversion Costs Applied		1,500
7.	Finished Goods	9,500	
	Work in Process—Bottling		9,500

The journal entries for the other work order are not shown but would follow a similar pattern.

SUMMARY

This chapter has presented the basic framework for a process-costing system. The cost flows, journal entries, and the cost of production report have been described. Additionally, we have shown that process costing can be used in service organizations and JIT manufacturing firms. These two settings often have no significant work-in-process inventories and, therefore, present the simplest and most straightforward applications of the approach.

The use of process costing is complicated by the presence of work-in-process inventories. When work-in-process inventories are present, equivalent units must be used to measure output. Also, with beginning work-in-process inventories, we must decide what to do with prior-period work and prior-period costs. Two methods were described for dealing with beginning work-in-process inventories: the FIFO method and the weighted average method. The FIFO approach is theoretically appealing because it follows the process-costing principle: a period's unit cost is computed by dividing the costs of the period by the output of the period. To accomplish this, prior-period work and costs must be excluded. This work and its costs must be tracked separately, creating some complexity in the approach. The weighted average approach is less complicated but poses some problems when control and accuracy issues are important.

The chapter also illustrates how to apply process costing to a multiple department setting. We explored the effect of transferred-in goods and possible changes in the way output is measured. Finally, we introduced a hybrid costing approach called operation costing. This approach is useful for manufacturing settings where batches of homogeneous products are produced.

Appendix: Spoiled Units

OBJECTIVE 8

Explain how spoilage is treated in a process-costing system.

When spoilage takes place in a process-costing situation, its effects ripple through the cost of production report. Let's take Payson Company as an example. Payson Com-

pany produces a product that passes through two departments: mixing and cooking. In the mixing department, all direct materials are added at the beginning of the process. All other manufacturing inputs are added uniformly. The following information pertains to the mixing department for February:

a. Beginning work in process (BWIP), February 1: 100,000 pounds, 40 percent complete with respect to conversion costs. The costs assigned to this work are as follows:

Direct materials	$20,000
Direct labor	10,000
Overhead	30,000

b. Ending work in process (EWIP), February 28: 50,000 pounds, 60 percent complete with respect to conversion costs.

c. Units completed and transferred out: 360,000 pounds. The following costs were added during the month:

Direct materials	$211,000
Direct labor	100,000
Overhead	270,000

d. All units are inspected at the 80 percent point of completion, and any spoiled units identified are discarded. During February, 10,000 pounds were spoiled. We can look at the five steps of the cost of production report. First, we must create a physical flow schedule.

Units to account for:	
Units, beginning work in process	100,000
Units started	320,000
Total units to account for	420,000
Units accounted for:	
Units transferred out	360,000
Units spoiled	10,000
Units, ending work in process	50,000
Total units accounted for	420,000

The second step is the creation of a schedule of equivalent units, shown below.

	Direct Materials	*Conversion Costs*
Units completed	360,000	360,000
Units spoiled × Percentage complete:		
Direct materials (10,000 × 100%)	10,000	
Conversion costs (10,000 × 80%)		8,000
Units in ending work in process × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	420,000	398,000

The cost per equivalent unit is as follows:

DM unit cost ($20,000 + $211,000)/420,000	$0.55
CC unit cost ($40,000 + $370,000)/398,000	1.03*
Total cost per equivalent unit	$1.58

*Rounded.

Now we must calculate the cost of goods transferred out and the cost of ending work in process. If the spoilage is normal (expected), the cost of spoiled units is added

to the cost of the good units. In this case, the inspection occurred at the 80 percent point of completion. Therefore, none of the spoiled units are from ending work in process (as these units are only 60 percent complete and have not yet been inspected). Thus, all spoilage cost is assigned to the good units transferred out.

Cost of goods transferred out:	
Good units $1.58 × 360,000	$568,800
Spoiled units ($0.55 × 10,000) + ($1.03 × 8,000)	13,740
	$582,540

Cost of ending work in process = ($0.55 × 50,000) + ($1.03 × 30,000) = $58,400

Costs are reconciled as follows:

Costs to account for:	
Beginning work in process	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$582,540
Ending work in process	58,400
Total costs accounted for	$640,940*

*$60 difference is due to rounding.

Suppose that the spoilage was abnormal. Then the spoilage cost is assigned to a spoilage loss account. The costs are accounted for as follows:

Cost of good units transferred out = $1.58 × 360,000 = $568,800
Spoiled units = ($0.55 × 10,000) + ($1.03 × 8,000) = $13,740
Cost of ending work in process = ($0.55 × 50,000) + ($1.03 × 30,000) = $58,400

Costs are reconciled as follows:

Costs to account for:	
Beginning work in process	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$568,800
Loss from abnormal spoilage	13,740
Ending work in process	58,400
Total costs accounted for	$640,940*

*$60 difference is due to rounding.

Notice the difference between the treatment of normal and abnormal spoilage. When spoilage is assumed to be normal, it is not tracked separately but is embedded in the total cost of good units. As a result, no one knows precisely how much spoilage adds to total manufacturing costs and whether or not an effort should be made to reduce it. The treatment of spoilage as abnormal is more in keeping with an emphasis on total quality management where there is no tolerance allowed for waste. At least the product cost of spoiled goods is tracked in a separate account. Of course, a factory engaged in total quality management would not stop at classifying spoilage as abnormal.

It would also identify the activities that are associated with these spoiled goods in an effort to discover the root causes of poor quality.

REVIEW PROBLEM AND SOLUTION

Physical Flow, Equivalent Units

Payson Company produces a product that passes through two departments: mixing and cooking. Both departments use the weighted average method. In the mixing department, all direct materials are added at the beginning of the process. All other manufacturing inputs are added uniformly. The following information pertains to the mixing department for February:

a. Beginning work in process (BWIP), February 1: 100,000 pounds, 100 percent complete with respect to direct materials and 40 percent complete with respect to conversion costs. The costs assigned to this work are as follows:

Direct materials	$20,000
Direct labor	10,000
Overhead	30,000

b. Ending work in process (EWIP), February 28: 50,000 pounds, 100 percent complete with respect to direct materials and 60 percent complete with respect to conversion costs.

c. Units completed and transferred out: 370,000 pounds. The following costs were added during the month:

Direct materials	$211,000
Direct labor	100,000
Overhead	270,000

Required:

1. Prepare a physical flow schedule.
2. Prepare a schedule of equivalent units.
3. Compute the cost per equivalent unit.
4. Compute the cost of goods transferred out and the cost of ending work in process.
5. Prepare a cost reconciliation.
6. Repeat Requirements 2–4 using the FIFO method.

SOLUTION

1. Physical flow schedule:

Units to account for:		
Units, BWIP		100,000
Units started		320,000
Total units to account for		420,000
Units accounted for:		
Units completed and transferred out:		
Started and completed	270,000	
From BWIP	100,000	370,000
Units, EWIP		50,000
Total units accounted for		420,000

2. Schedule of equivalent units:

	Direct Materials	*Conversion Costs*
Units completed	370,000	370,000
Units, EWIP × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	420,000	400,000

3. Cost per equivalent unit:

DM unit cost ($20,000 + $211,000)/420,000	$0.550
CC unit cost ($40,000 + $370,000)/400,000	1.025
Total cost per equivalent unit	$1.575

4. Cost of goods transferred out and cost of ending work in process:

Cost of goods transferred out = $1.575 × 370,000 = $582,750
Cost of EWIP = ($0.55 × 50,000) + ($1.025 × 30,000) = $58,250

5. Cost reconciliation:

Costs to account for:	
BWIP	$ 60,000
Costs added	581,000
Total costs to account for	$641,000
Costs accounted for:	
Goods transferred out	$582,750
EWIP	58,250
Total costs accounted for	$641,000

6. FIFO results:

Schedule of equivalent units:

	Direct Materials	*Conversion Costs*
Units started and completed	270,000	270,000
Units, BWIP × Percentage complete:	—	60,000
Units, EWIP × Percentage complete:		
Direct materials (50,000 × 100%)	50,000	—
Conversion costs (50,000 × 60%)	—	30,000
Equivalent units of output	320,000	360,000

Cost per equivalent unit:

DM unit cost $211,000/320,000	$0.659*
CC unit cost $370,000/360,000	1.028*
Total cost per equivalent unit	$1.687

*Rounded.

Cost of goods transferred out and cost of ending work in process:

$$\text{Cost of goods transferred out} = (\$1.687 \times 270{,}000) + (\$1.028 \times 60{,}000) + \$60{,}000 = \$577{,}170$$

$$\text{Cost of EWIP} = (\$0.659 \times 50{,}000) + (\$1.028 \times 30{,}000) = \$63{,}790$$

KEY TERMS

Batch production processes 249
Cost reconciliation 235
Equivalent units of output 233
FIFO costing method 236
Operation costing 249
Physical flow schedule 237
Process 226
Process-costing principle 232
Production report 229
Transferred-in cost 229
Weighted average costing method 241
Work orders 249

QUESTIONS FOR WRITING AND DISCUSSION

1. What is a process? Provide an example that illustrates the definition.
2. Describe the differences between process costing and job-order costing.
3. What journal entry would be made as goods are transferred out from one department to another department? From the final department to the warehouse?
4. What are transferred-in costs?
5. Explain why transferred-in costs are a special type of material for the receiving department.
6. What is a production report? What purpose does this report serve?
7. Can process costing be used for a service organization? Explain.
   Explain how process costing can be used for JIT manufacturing firms.
8. What are equivalent units? Why are they needed in a process-costing system?
9. How is the equivalent unit calculation affected when direct materials are added at the beginning or end of the process rather than uniformly throughout the process?
10. Describe the five steps in accounting for the manufacturing activity of a processing department, and indicate how they interrelate.
11. Under the weighted average method, how are prior-period costs and output treated? How are they treated under the FIFO method?
12. Under what conditions will the weighted average and FIFO methods give essentially the same results?
13. In assigning costs to goods transferred out, how do the weighted average and FIFO methods differ?
14. How are transferred-in costs treated in the calculation of equivalent units?
15. What is operation costing? When is it used?

EXERCISES

6-1 JOURNAL ENTRIES

LO1, LO2

Lawson Company has three process departments: mixing, encapsulating, and bottling. At the beginning of the fiscal year (July 1), there were no work-in-process or finished goods inventories. The following data are available for the month of July:

Department	*Manufacturing Costs Added**	*Ending Work in Process*
Mixing	$540,000	$135,000
Encapsulating	495,000	112,500
Bottling	450,000	22,500

*Includes only the direct materials, direct labor, and the overhead used to process the partially finished goods received from the prior department. The transferred-in cost is not included.

Required:

1. Prepare journal entries that show the transfer of costs from one department to the next (including the entry to transfer the costs of the final department).
2. Prepare T-accounts for the entries made in Requirement 1. Use arrows to show the flow of costs.

6-2 Process Costing, Service Organization

LO2

A local barbershop cuts the hair of 1,000 customers per month. The clients are men, and the barbers offer no special styling. During the month of March, 1,000 customers were serviced. The cost of haircuts includes the following:

Direct labor	$ 7,000
Direct materials	1,000
Overhead	2,000
Total	$10,000

Required:

1. Explain why process costing is appropriate for this haircutting operation.
2. Calculate the cost per haircut.
3. Can you identify some possible direct materials used for this haircutting service? Is the usage of direct materials typical of services? If so, provide examples of services that use direct materials. Can you think of some services that would not use direct materials?

6-3 JIT Manufacturing and Process Costing, ABC

LO1, LO2

Manzer Company uses JIT manufacturing. Several manufacturing cells are set up within one of its factories. One of the cells makes speakers for computers. The cost of production for the month of April is as follows:

Cell labor	$ 80,000
Direct materials	200,000
Overhead	160,000
Total	$440,000

During April, 10,000 sets of speakers were produced and sold.

Required:

1. Explain why process costing can be used for computing the cost of production for the speakers.
2. Calculate the cost per unit for a speaker.
3. Explain how activity-based costing can be used to determine the overhead assigned to the cell.

6-4 Physical Flow, Equivalent Units, Unit Costs, No Beginning WIP Inventory, Activity-Based Costing

LO2, LO3

Mizukawa, Inc., produces a subassembly used in the production of hydraulic cylinders. The subassemblies are produced in three departments: plate cutting, rod cutting, and welding. Overhead is applied using the following drivers and activity rates:

Driver	*Rate*	*Actual Usage (by Plate Cutting)*
Direct labor cost	150% of direct labor cost	$366,000
Inspection hours	$20 per hour	3,725 hours
Purchase orders	$500 per order	400 orders

Other data for the plate cutting department are as follows:

Beginning work in process	—
Units started	370,000
Direct materials cost	$1,850,000
Units, ending work in process (100% materials; 80% conversion)	20,000

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for:
   a. Direct materials
   b. Conversion costs
3. Calculate unit costs for:
   a. Direct materials
   b. Conversion costs
   c. Total manufacturing
4. Provide the following information:
   a. The total cost of units transferred out
   b. The journal entry for transferring costs from plate cutting to welding
   c. The cost assigned to units in ending inventory

6-5 Production Report, No Beginning Inventory

LO1, LO3

Deercreek Company manufactures insect repellant. The mixing department, the first process department, mixes the chemicals required for the repellant. The following data are for 2007:

Work in process, January 1, 2007	—
Gallons started	300,000
Gallons transferred out	25,000
Direct materials cost	$300,000
Direct labor cost	$595,200
Overhead applied	$892,800

Direct materials are added at the beginning of the process. Ending inventory is 95 percent complete with respect to direct labor and overhead.

Required:

Prepare a production report for the mixing department for 2007.

6-6 Weighted Average Method, FIFO Method, Physical Flow, Equivalent Units

LO3, LO4, LO5

Darim Company manufactures a product that passes through two processes: fabrication and assembly. The following information was obtained for the fabrication department for June:

a. All materials are added at the beginning of the process.
b. Beginning work in process had 60,000 units, 30 percent complete with respect to conversion costs.
c. Ending work in process had 12,000 units, 25 percent complete with respect to conversion costs.
d. Started in process, 75,000 units.

Required:

1. Prepare a physical flow schedule.
2. Compute equivalent units using the weighted average method.
3. Compute equivalent units using the FIFO method.

6-7 FIFO Method, Valuation of Goods Transferred Out and Ending Work in Process

LO4

Alden Company uses the FIFO method to account for the costs of production. For crushing, the first processing department, the following equivalent units schedule has been prepared:

	Direct Materials	*Conversion Costs*
Units started and completed	22,000	22,000
Units, beginning work in process:		
10,000 × 0%	—	—
10,000 × 40%	—	4,000
Units, ending work in process:		
6,000 × 100%	6,000	—
6,000 × 75%	—	4,500
Equivalent units of output	28,000	30,500

The cost per equivalent unit for the period was as follows:

Direct materials	$3.00
Conversion costs	5.00
Total	$8.00

The cost of beginning work in process was direct materials, $30,000; conversion costs, $25,000.

Required:

1. Determine the cost of ending work in process and the cost of goods transferred out.
2. Prepare a physical flow schedule.

6-8 Equivalent Units—Weighted Average Method

LO5 The following data are for four independent process-costing departments. Inputs are added continuously.

	A	*B*	*C*	*D*
Beginning inventory	3,000	2,000	—	25,000
Percent completion	30%	75%	—	60%
Units started	19,000	20,000	48,000	35,000
Ending inventory	4,000	—	8,000	10,000
Percent completion	20%	—	25%	10%

Required:

Compute the equivalent units of production for each of the preceding departments using the weighted average method.

6-9 Equivalent Units, FIFO Method

LO4 Using the data from **Exercise 6-8**, compute the equivalent units of production for each of the four departments using the FIFO method.

6-10 Weighted Average Method, Unit Cost, Valuation of Goods Transferred Out and Ending Work in Process

LO5 Watson Products, Inc., produces plastic cases used for video cameras. The product passes through three departments. For May, the following equivalent units schedule was prepared for the first department:

	Direct Materials	*Conversion Costs*
Units completed	5,000	5,000
Units, ending work in process × Percentage complete:		
6,000 × 100%	6,000	—
6,000 × 50%	—	3,000
Equivalent units of output	11,000	8,000

Costs assigned to beginning work in process: direct materials, $30,000; conversion costs, $5,000. Manufacturing costs incurred during May: direct materials, $25,000; conversion costs, $65,000. Watson uses the weighted average method.

Required:

1. Compute the unit cost for May.
2. Determine the cost of ending work in process and the cost of goods transferred out.

6-11 FIFO Method, Unit Cost, Valuation of Goods Transferred Out and Ending Work in Process

LO4 Dama Company produces women's blouses and uses the FIFO method to account for its manufacturing costs. The product Dama makes passes through two processes:

cutting and sewing. During April, Dama's controller prepared the following equivalent units schedule for the cutting department:

	Direct Materials	*Conversion Costs*
Units started and completed	40,000	40,000
Units, beginning work in process:		
10,000 × 0%	—	—
10,000 × 50%	—	5,000
Units, ending work in process:		
20,000 × 100%	20,000	—
20,000 × 25%	—	5,000
Equivalent units of output	60,000	50,000

Costs in beginning work in process were direct materials, $20,000; conversion costs, $80,000. Manufacturing costs incurred during April were direct materials, $240,000; conversion costs, $320,000.

Required:

1. Prepare a physical flow schedule for April.
2. Compute the cost per equivalent unit for April.
3. Determine the cost of ending work in process and the cost of goods transferred out.
4. Prepare the journal entry that transfers the costs from cutting to sewing.

6-12 Weighted Average Method, Equivalent Units, Unit Cost, Multiple Departments

LO5, LO6

Fordman Company has a product that passes through two processes: grinding and polishing. During December, the grinding department transferred 20,000 units to the polishing department. The cost of the units transferred into the second department was $40,000. Direct materials are added uniformly in the second process. Units are measured the same way in both departments.

The second department (polishing) had the following physical flow schedule for December:

Units to account for:	
Units, beginning work in process	4,000 (40% complete)
Units started	?
Total units to account for	?
Units accounted for:	
Units, ending work in process	8,000 (50% complete)
Units completed	?
Units accounted for	?

Costs in beginning work in process for the polishing department were direct materials, $5,000; conversion costs, $6,000; and transferred in, $8,000. Costs added during the month: materials, $32,000; conversion costs, $50,000; and transferred in, $40,000.

Required:

1. Assuming the use of the weighted average method, prepare a schedule of equivalent units.
2. Compute the unit cost for the month.

6-13 FIFO Method, Equivalent Units, Unit Cost, Multiple Departments

LO4, LO6

Using the same data found in **Exercise 6-12**, assume the company uses the FIFO method.

Required:

Prepare a schedule of equivalent units, and compute the unit cost for the month of December.

6-14 Journal Entries, Cost of Ending Inventories

LO1, LO3

Baxter Company has two processing departments: assembly and finishing. A predetermined overhead rate of $10 per direct labor hour is used to assign overhead to production. The company experienced the following operating activity for April:

a. Issued materials to assembly, $24,000.
b. Incurred direct labor cost: assembly, 500 hours at $9.20 per hour; finishing, 400 hours at $8 per hour.
c. Applied overhead to production.
d. Transferred goods to finishing, $32,500.
e. Transferred goods to finished goods warehouse, $20,500.
f. Incurred actual overhead, $10,000.

Required:

1. Prepare the required journal entries for the preceding transactions.
2. Assuming assembly and finishing have no beginning work-in-process inventories, determine the cost of each department's ending work-in-process inventories.

6-15 Operation Costing: Bread Manufacturing

LO7

Tasty Bread makes and supplies bread throughout the state of Kansas. Three types of bread are produced: loaves, rolls, and buns. Seven operations describe the production process.

a. Mixing: Flour, milk, yeast, salt, butter, and so on, are mixed in a large vat.
b. Shaping: A conveyor belt transfers the dough to a machine that weighs it and shapes it into loaves, rolls, or buns, depending on the type being produced.
c. Rising: The individually shaped dough is allowed to sit and rise.
d. Baking: The dough is moved to a 100-foot-long funnel oven. (The dough enters the oven on racks and spends 20 minutes moving slowly through the oven.)
e. Cooling: The bread is removed from the oven and allowed to cool.
f. Slicing: For loaves and buns (hamburger and hot dog), the bread is sliced.
g. Packaging: The bread is wrapped (packaged).

Tasty produces its products in batches. The size of the batch depends on the individual orders that must be filled (orders come from retail grocers throughout the state). Usually, as soon as one batch is mixed, a second batch begins the mixing operation.

Required:

1. Identify the conditions that must be present for operation costing to be used in this setting. If these conditions are not met, explain how process costing would be used. If process costing is used, would you recommend the weighted average method or the FIFO method? Explain.
2. Assume that operation costing is the best approach for this bread manufacturer. Describe in detail how you would use operation costing. Use a batch of dinner rolls (consisting of 1,000 packages of 12 rolls) and a batch of whole wheat loaves (consisting of 5,000, 24-oz. sliced loaves) as examples.

PROBLEMS

6-16 Weighted Average Method, Physical Flow, Equivalent Units, Unit Costs, Cost Assignment, ABC

LO2, LO3, LO5

Norton Parts, Inc., manufactures bumpers (plastic or metal, depending on the plant) for automobiles. Each bumper passes through three processes: molding, drilling, and painting. In August, the molding department of the Oklahoma City plant reported the following data:

a. In molding, all direct materials are added at the beginning of the process.
b. Beginning work in process consisted of 27,000 units, 20 percent complete with respect to direct labor and overhead. Costs in beginning inventory included direct materials, $810,000; direct labor, $148,400; and applied overhead, $100,000.
c. Costs added to production during the month were direct materials, $1,710,000 and direct labor, $2,314,100. Overhead was assigned using the following activity information:

Activity	*Rate*	*Actual Driver Usage*
Inspection	$100 per inspection hour	4,000 inspection hours
Maintenance	$500 per maintenance hour	1,600 maintenance hours
Receiving	$200 per receiving order	2,000 receiving orders

d. At the end of the month, 81,000 units were transferred out to drilling, leaving 9,000 units in ending work in process, 25 percent complete.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for direct materials and conversion costs.
3. Compute unit cost.
4. Calculate the cost of goods transferred to drilling at the end of the month. Calculate the cost of ending inventory.
5. Prepare the journal entry that transfers the goods from molding to drilling.

6-17 FIFO Method, Physical Flow, Equivalent Units, Unit Costs, Cost Assignment

LO3, LO4

Refer to the data in **Problem 6-16**. Assume that the FIFO method is used.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production for direct materials and conversion costs.
3. Compute unit cost.
4. Calculate the cost of goods transferred to drilling at the end of the month. Calculate the cost of ending inventory.

6-18 Weighted Average Method, Single Department Analysis, Uniform Costs

LO5

Stewart Company produces a product that passes through three processes: fabrication, assembly, and finishing. All manufacturing costs are added uniformly for both processes. The following information was obtained for the assembly department for May 2007:

a. Work in process, May 1, had 10,000 units (40 percent completed) and the following costs:

Direct materials	$12,000
Direct labor	18,000
Overhead	6,000

b. During the month of May, 30,000 units were completed and transferred to the finishing department, and the following costs were added to production:

Direct materials	$36,000
Direct labor	24,000
Overhead	18,000

c. On May 30, there were 7,500 partially completed units in process. These units were 80 percent complete.

Required:

Prepare a cost of production report for the assembly department for May using the weighted average method of costing. The report should disclose the physical flow of units, equivalent units, and unit costs and should track the disposition of manufacturing costs.

6-19 FIFO Method, Single Department Analysis, One Cost Category

LO4

Refer to the data in **Problem 6-18**.

Required:

Prepare a cost of production report for the assembly department for May using the FIFO method of costing.

6-20 Service Organization with Work-in-Process Inventories, Multiple Departments, FIFO Method, Unit Cost

LO3, LO4, LO6

Granger Credit Corporation is a wholly owned subsidiary of a large manufacturer of computers. Granger is in the business of financing computers, software, and other services that the parent corporation sells. Granger has two departments that are involved in financing services: the credit department and the business practices department. The credit department receives requests for financing from field sales representatives, records customer information on a preprinted form, and then enters the information into the computer system to check the creditworthiness of the customer. (Other actions may be taken if the customer is not in the database.) Once creditworthiness information is known, a printout is produced with this information plus other customer specific information. The completed form is transferred to the business practices department.

The business practices department modifies the standard loan covenant as needed (in response to customer request or customer risk profile). When this activity is completed, the loan is priced. This is done by keying information from the partially processed form into a personal computer spreadsheet program. The program provides a recommended interest rate for the loan. Finally, a form specifying the loan terms is attached to the transferred-in document. A copy of the loan-term form is sent to the sales representative and serves as the quote letter.

The following cost and service activity data for the business practices department are provided for the month of May:

Transferred-in applications	2,800
Applications in process, May 1, 40% complete*	500
Applications in process, May 31, 25% complete*	800

*All materials and supplies are used at the end of the process.

	Transferred In	*Direct Materials*	*Conversion Costs*
Costs:			
Beginning work in process	$ 4,500	—	$ 2,800
Costs added	28,000	$1,250	37,500

Required:

1. How would you define the output of the business practices department?
2. Using the FIFO method, prepare the following for the business practices department:
   a. A physical flow schedule
   b. An equivalent units schedule
   c. Calculation of unit costs
   d. Cost of ending work in process and cost of units transferred out
   e. A cost reconciliation

6-21 Weighted Average Method, Journal Entries

LO1, LO5, LO6

Muskoge Company uses a process-costing system. The company manufactures a product that is processed in two departments: molding and assembly. In the molding department, direct materials are added at the beginning of the process; in the assembly department, additional direct materials are added at the end of the process. In both departments, conversion costs are incurred uniformly throughout the process. As work is completed, it is transferred out. The following table summarizes the production activity and costs for February:

	Molding	*Assembly*
Beginning inventories:		
Physical units	10,000	8,000
Costs:		
Transferred in	—	$45,200
Direct materials	$22,000	—
Conversion costs	$13,800	$16,800
Current production:		
Units started	25,000	?
Units transferred out	30,000	35,000
Costs:		
Transferred in	—	?
Direct materials	$56,250	$39,550
Conversion costs	$103,500	$136,500
Percentage of completion:		
Beginning inventory	40%	50%
Ending inventory	80%	50%

Required:

1. Using the weighted average method, prepare the following for the molding department:
   a. A physical flow schedule
   b. An equivalent units calculation
   c. Calculation of unit costs
   d. Cost of ending work in process and cost of goods transferred out
   e. A cost reconciliation
2. Prepare journal entries that show the flow of manufacturing costs for the molding department.
3. Repeat Requirements 1 and 2 for the assembly department.

6-22 FIFO Method, Two-Department Analysis

LO2, LO4, LO6

Refer to the data in **Problem 6-21**.

Required:

Repeat the requirements in **Problem 6-21** using the FIFO method.

6-23 Weighted Average Method, Two-Department Analysis, Change in Output Measure

LO5, LO6

Healthway uses a process-costing system to compute the unit costs of the minerals that it produces. It has three departments: mixing, tableting, and bottling. In mixing, the ingredients for the minerals are measured, sifted, and blended together. The mix is transferred out in gallon containers. The tableting department takes the powdered mix and places it in capsules. One gallon of powdered mix converts to 1,600 capsules. After the capsules are filled and polished, they are transferred to bottling where they are placed in bottles, which are then affixed with a safety seal and a lid and labeled. Each bottle receives 50 capsules.

During July, the following results are available for the first two departments (direct materials are added at the beginning in both departments):

	Mixing	*Tableting*
Beginning inventories:		
Physical units	5 gallons	4,000 capsules
Costs:		
Direct materials	$120	$32
Direct labor	$128	$20
Overhead	?	?
Transferred in	—	$140
Current production:		
Transferred out	125 gallons	198,000 capsules
Ending inventory	6 gallons	6,000 capsules
Costs:		
Direct materials	$3,144	$1,584
Transferred in	—	?
Direct labor	$4,096	$1,944
Overhead	?	?
Percentage of completion:		
Beginning inventory	40%	50%
Ending inventory	50%	40%

Overhead in both departments is applied as a percentage of direct labor costs. In the mixing department, overhead is 200 percent of direct labor. In the tableting department, the overhead rate is 150 percent of direct labor.

Required:

1. Prepare a production report for the mixing department using the weighted average method. Follow the five steps outlined in the chapter.
2. Prepare a production report for the tableting department. Follow the five steps outlined in the chapter.

6-24 FIFO Method, Two-Department Analysis

LO4, LO6

Refer to the data in **Problem 6-23**.

Required:

Prepare a production report for each department using the FIFO method.

6-25 Operation Costing: Unit Costs and Journal Entries

LO7

Jacson Company produces two brands of a popular pain medication: regular strength and extra strength. Regular strength is produced in tablet form, and extra strength is produced in capsule form. All direct materials needed for each batch are requisitioned at the start. The work orders for two batches of the products follow, along with some associated cost information:

	Work Order 121 (Regular Strength)	*Work Order 122 (Extra Strength)*
Direct materials (actual costs):	$9,000	$15,000
Applied conversion costs:		
Mixing	?	?
Tableting	$5,000	—
Encapsulating	—	$6,000
Bottling	?	?
Batch size (bottles of 100 units)	12,000	18,000

In the mixing department, conversion costs are applied on the basis of direct labor hours. Budgeted conversion costs for the department for the year were $60,000 for direct labor and $190,000 for overhead. Budgeted direct labor hours were 5,000. It takes one minute of labor time to mix the ingredients needed for a 100-unit bottle (for either product).

In the bottling department, conversion costs are applied on the basis of machine hours. Budgeted conversion costs for the department for the year were $400,000. Budgeted machine hours were 20,000. It takes one-half minute of machine time to fill a bottle of 100 units.

Required:

1. What are the conversion costs applied in the mixing department for each batch? The bottling department?
2. Calculate the cost per bottle for the regular and extra strength pain medications.
3. Prepare the journal entries that record the costs of the 12,000 regular strength batch as it moves through the various operations.

4. Suppose that the direct materials are requisitioned by each department as needed for a batch. For the 12,000 regular strength batch, direct materials are requisitioned for the mixing and bottling departments. Assume that the amount of cost is split evenly between the two departments. How will this change the journal entries made in Requirement 3?

6-26 Case on Process Costing, Operation Costing, Impact on Resource Allocation Decision

LO3, LO5, LO7

Golding Manufacturing, a division of Farnsworth Sporting, Inc., produces two different models of bows and eight models of knives. The bow-manufacturing process involves the production of two major subassemblies: the limbs and the handle. The limbs pass through four sequential processes before reaching final assembly: lay-up, molding, fabricating, and finishing. In the lay-up department, limbs are created by laminating layers of wood. In molding, the limbs are heat treated, under pressure, to form a strong resilient limb. In the fabricating department, any protruding glue or other processing residue is removed. Finally, in finishing, the limbs are cleaned with acetone, dried, and sprayed with the final finishes.

The handles pass through two processes before reaching final assembly: pattern and finishing. In the pattern department, blocks of wood are fed into a machine that is set to shape the handles. Different patterns are possible, depending on the machine's setting. After coming out of the machine, the handles are cleaned and smoothed. They then pass to the finishing department where they are sprayed with the final finishes. In final assembly, the limbs and handles are assembled into different models using purchased parts such as pulley assemblies, weight adjustment bolts, side plates, and string.

Golding, since its inception, has been using process costing to assign product costs. A predetermined overhead rate is used based on direct labor dollars (80 percent of direct labor dollars). Recently, Golding has hired a new controller, Karen Jenkins. After reviewing the product costing procedures, Karen requested a meeting with the divisional manager, Aaron Suhr. The following is a transcript of their conversation:

KAREN: Aaron, I have some concerns about our cost accounting system. We make two different models of bows and are treating them as if they were the same product. Now I know that the only real difference between the models is the handle. The processing of the handles is the same, but the handles differ significantly in the amount and quality of wood used. Our current costing does not reflect this difference in direct materials input.

AARON: Your predecessor is responsible. He believed that tracking the difference in direct materials cost wasn't worth the effort. He simply didn't believe that it would make much difference in the unit cost of either model.

KAREN: Well, he may have been right, but I have my doubts. If there is a significant difference, it could affect our views of which model is more important to the company. The additional bookkeeping isn't very stringent. All we have to worry about is the pattern department. The other departments fit what I view as a process-costing pattern.

AARON: Why don't you look into it? If there is a significant difference, go ahead and adjust the costing system.

After the meeting, Karen decided to collect cost data on the two models: the Deluxe model and the Econo model. She decided to track the costs for one week. At the end of the week, she had collected the following data from the pattern department:

a. There were a total of 2,500 bows completed: 1,000 Deluxe models and 1,500 Econo models.
b. There was no beginning work in process; however, there were 300 units in ending work in process: 200 Deluxe and 100 Econo models. Both models were 80

percent complete with respect to conversion costs and 100 percent complete with respect to direct materials.

c. The pattern department experienced the following costs:

Direct materials	$114,000
Direct labor	45,667

d. On an experimental basis, the requisition forms for direct materials were modified to identify the dollar value of the direct materials used by the Econo and Deluxe models:

Econo model	$30,000
Deluxe model	84,000

Required:

1. Compute the unit cost for the handles produced by the pattern department assuming that process costing is totally appropriate.
2. Compute the unit cost of each handle using the separate cost information provided on materials.
3. Compare the unit costs computed in Requirements 1 and 2. Is Karen justified in her belief that a pure process-costing relationship is not appropriate? Describe the costing system that you would recommend.
4. In the past, the marketing manager has requested more money for advertising the Econo line. Aaron has repeatedly refused to grant any increase in this product's advertising budget because its per-unit profit (selling price less manufacturing cost) is so low. Given the results in Requirements 1 through 3, was Aaron justified in his position?

6-27 Appendix: Normal and Abnormal Spoilage

LO5, LO8

Larkin Company produces leather strips for western belts using three processes: cutting, design and coloring, and punching. The weighted average method is used for all three departments. The following information pertains to the design and coloring department for the month of June.

a. There was no beginning work in process.
b. There were 400,000 units transferred in from cutting.
c. Ending work in process, June 30: 50,000 strips, 80 percent complete with respect to conversion costs.
d. Units completed and transferred out: 330,000 strips. The following costs were added during the month:

Transferred in	$2,000,000
Direct materials	600,000
Conversion costs	780,000

e. Direct materials are added at the beginning of the process.
f. Inspection takes place at the end of the process. All spoilage is considered normal.

Required:

1. Calculate equivalent units of production for transferred-in materials, direct materials added, and conversion costs.
2. Calculate unit costs for the three categories of Requirement 1.
3. What is the total cost of units transferred out? What is the cost of ending work-in-process inventory? How is the cost of spoilage treated?
4. Assume that all spoilage is considered abnormal. Now, how is spoilage treated? Give the journal entry to account for the cost of the spoiled units. Some companies view all spoilage as abnormal. Explain why.

5. Assume that 80 percent of the units spoiled are abnormal and 20 percent are normal spoilage. Show the spoilage treatment for this scenario.

6-28 Appendix: Normal and Abnormal Spoilage in Process Costing

LO8 Novel Toys, Inc., manufactures plastic water guns. Each gun's left and right frames are produced in the molding department. The left and right frames are then transferred to the assembly department where the trigger mechanism is inserted and the halves are glued together. (The left and right halves together define the unit of output for the molding department.) In June, the molding department reported the following data:

a. In the molding department, all direct materials are added at the beginning of the process.
b. Beginning work in process consisted of 3,000 units, 20 percent complete with respect to direct labor and overhead. Costs in beginning inventory included direct materials, $450; and conversion costs, $138.
c. Costs added to production during the month were direct materials, $950; and conversion costs, $2,174.50.
d. Inspection takes place at the end of the process. Malformed units are discarded. All spoilage is considered abnormal.
e. During the month, 7,000 units were started, and 8,000 good units were transferred out to finishing. All other units finished were malformed and discarded. There were 1,000 units that remained in ending work in process, 25 percent complete.

Required:

1. Prepare a physical flow schedule.
2. Calculate equivalent units of production using the weighted average method.
3. Calculate the unit cost.
4. What is the cost of goods transferred out? Ending work in process? Loss due to spoilage?
5. Prepare the journal entry to remove spoilage from the molding department.

6-29 Appendix: Normal and Abnormal Spoilage in Process Costing, Changes in Output Measures, Multiple Departments

LO6, LO8 Grayson Company produces an industrial chemical used for cleaning and lubricating machinery. In the mixing department, liquid and dry chemicals are blended to form slurry. Output is measured in gallons. In the baking department, the slurry is subjected to high heat, and the residue appears in irregular lumps. Output is measured in pounds. In the grinding department, the irregular lumps are ground into a powder, and this powder is placed in 50-pound bags. Output is measured in bags produced. In April, the company reported the following data:

a. The mixing department transferred 50,000 gallons to the baking department, costing $250,000. Each gallon of slurry weighs two pounds.
b. The baking department transferred 100,000 pounds (irregular lumps) to the grinding department. At the beginning of the month, there were 5,000 gallons of slurry in process, 25 percent complete, costing $35,000 (transferred-in cost of $25,000 plus conversion cost of $10,000). No additional direct materials are added in the baking department. At the end of April, there was no ending work in process. Conversion costs for the month totaled $205,000. Normal loss during baking is 5 percent of good output. All transferred-in materials are lost, but

since loss occurs uniformly throughout the process, only 50 percent of the conversion units are assumed to be lost.

c. The grinding department transferred 2,500 bags of chemicals to its finished goods warehouse. Beginning work in process for this department was 25,000 pounds, 40 percent complete with the following costs: transferred-in cost, $132,500 and conversion cost, $15,000. Bags are used at the end of the process and cost $1.50 each. During bagging, normally one out of every 11 bags is torn and must be discarded. No powder is lost (the tearing occurs when the bag is being attached to a funnel). Conversion costs for the month's production are $172,500. There is no ending work in process.

Required:

1. Calculate the cost per bag of chemicals transferred to the finished goods warehouse. Show all work necessary for the calculation.
2. Prepare the journal entries needed to remove spoilage from the baking and grinding departments.

6-30 Collaborative Learning Exercise: Structured Problem Solving (Case on Equivalent Units, Valuation of Work-in-Process Inventories, FIFO versus Weighted Average)

LO1, LO3, LO4, LO5, LO6

AKL Foundry manufactures metal components for different kinds of equipment used by the aerospace, commercial aircraft, medical equipment, and electronics industries. The company uses investment casting to produce the required components. Investment casting consists of creating, in wax, a replica of the final product and pouring a hard shell around it. After removing the wax, molten metal is poured into the resulting cavity. What remains after the shell is broken is the desired metal object ready to be put to its designated use.

Metal components pass through eight processes: gating, shell creating, foundry work, cut-off, grinding, finishing, welding, and strengthening. Gating creates the wax mold and clusters the wax pattern around a sprue (a hole through which the molten metal will be poured through the gates into the mold in the foundry process), which is joined and supported by gates (flow channels) to form a tree of patterns. In the shell creating process, the wax molds are alternately dipped in a ceramic slurry and a fluidized bed of progressively coarser refractory grain until a sufficiently thick shell (or mold) completely encases the wax pattern. After drying, the mold is sent to the foundry process. Here, the wax is melted out of the mold, and the shell is fired, strengthened, and brought to the proper temperature. Molten metal is then poured into the dewaxed shell. Finally, the ceramic shell is removed, and the finished product is sent to the cut-off process, where the parts are separated from the tree by the use of a band saw. The parts are then sent to grinding, where the gates that allowed the molten metal to flow into the ceramic cavities are ground off using large abrasive grinders. In finishing, rough edges caused by the grinders are removed by small hand-held pneumatic tools. Parts that are flawed at this point are sent to welding for corrective treatment. The last process uses heat to treat the parts to bring them to the desired strength.

In 2007, the two partners who owned AKL Foundry decided to split up and divide the business. In dissolving their business relationship, they were faced with the problem of dividing the business assets equitably. Since the company had two plants—one in Arizona and one in New Mexico—a suggestion was made to split the business on the basis of geographic location—one partner would assume ownership of the plant in New Mexico and the other would assume ownership of the plant in Arizona. How-

ever, this arrangement had one major complication: the amount of work-in-process inventory located in the Arizona plant.

The Arizona facilities had been in operation for more than a decade and were full of work in process. The New Mexico facility had been operational for only two years and had much smaller work-in-process inventories. The partner located in New Mexico argued that to disregard the unequal value of the work-in-process inventories would be grossly unfair.

Unfortunately, during the entire business history of AKL Foundry, work-in-process inventories had never been assigned any value. In computing the cost of goods sold each year, the company had followed the policy of adding depreciation to the out-of-pocket costs of direct labor, direct materials, and overhead. Accruals for the company are nearly nonexistent, and there are hardly ever any ending inventories of materials.

During 2007, the Arizona plant had sales of $2,028,670. The cost of goods sold is itemized as follows:

Direct materials	$378,000
Direct labor	530,300
Overhead	643,518

Upon request, the owners of AKL provided the following supplementary information (percentages are cumulative):

	Costs Used by Each Process as a Percentage of Total Cost	
	Direct Materials	*Direct Total Labor Cost*
Gating	23%	35%
Shell creating	70	50
Foundry work	100	70
Cut-off	100	72
Grinding	100	80
Finishing	100	90
Welding	100	93
Strengthening	100	100

The gating department had 10,000 units in beginning work in process, 60 percent complete. Assume that all materials are added at the beginning of each process. During the year, 50,000 units were completed and transferred out. The ending inventory had 11,000 unfinished units, 60 percent complete.

Required:

Form groups of three to five students. Each group will act as a consulting team to solve the valuation problem for AKL Foundry (for a time specified by the instructor within class). At the end of the indicated time, one person from each group will be chosen by the instructor to act as the spokesperson for the group. Thus, every member of the group should be prepared to provide their group's solution. Each group should answer the following questions:

1. The partners of AKL want a reasonable estimate of the cost of work-in-process inventories. Using the gating department's inventory as an example, prepare an estimate of the cost of the ending work in process. What assumptions did you make? Did you use the FIFO or weighted average method? Why?
2. Assume that the shell creating process has 8,000 units in beginning work in process, 20 percent complete. During the year, 50,000 units were completed and

transferred out. (All 50,000 units were sold; no other units were sold.) The ending work-in-process inventory had 8,000 units, 30 percent complete. Compute the value of the shell creating department's ending work in process. What additional assumptions had to be made?

6-31 Collaborative Learning Exercise: Jigsaw Method for Collaborative Learning, Cost of Production Report, Ethical Behavior

LO3

Consider the following conversation between Keri Swasey, manager of a division that produces riding lawn mowers, and her controller, Stoney Lawson, a CMA and CPA:

KERI: Stoney, we have a real problem. Our operating cash is too low, and we are in desperate need of a loan. As you know, our financial position is marginal, and we need to show as much income as possible—and our assets need bolstering as well.

STONEY: I understand the problem, but I don't see what can be done at this point. This is the last week of the fiscal year, and it looks as if we'll report income just slightly above break even.

KERI: I know all this. What we need is some creative accounting. I have an idea that might help us, and I wanted to see if you would go along with it. We have 600 partially finished mowers in process, about 20 percent complete. That compares with the 3,000 units that we completed and sold during the year. When you computed the per-unit cost, you used 3,120 equivalent units, giving us a manufacturing cost of $1,500 per unit. That per-unit cost gives us cost of goods sold equal to $4.5 million and ending work in process worth $180,000. The presence of the work in process gives us a chance to improve our financial position. If we report the units in work in process as 80 percent complete, this will increase our equivalent units to 3,480. This, in turn, will decrease our unit cost to about $1,345 and cost of goods sold to $4.035 million. The value of our work in process will increase to $645,600. With those financial stats, the loan would be a cinch.

STONEY: Keri, I don't know. What you're suggesting is risky. It wouldn't take much auditing skill to catch this one.

KERI: You don't have to worry about that. The auditors won't be here for at least six to eight more weeks. By that time, we can have those partially completed units completed and sold. I can bury the labor cost by having some of our more loyal workers work overtime for some bonuses. The overtime will never be reported. And, as you know, bonuses come out of the corporate budget and are assigned to overhead—next year's overhead. Stoney, this will work. If we look good and get the loan to boot, corporate headquarters will treat us well. If we don't do this, we could lose our jobs.

Required:

Form groups of three to five students, where the total number of groups is divisible by four. The numbers 1, 2, 3, or 4 will be assigned to each group. Groups with number 1 will solve Requirement 1, groups with number 2 will solve Requirement 2, etc. Each group will share their answers with the other groups.

1. Should Stoney agree to Keri's proposal? Why or why not? To assist in deciding, review the standards of ethical conduct for management accountants described in Chapter 1. Do any apply?
2. Assume that Stoney refuses to cooperate and that Keri accepts this decision and drops the matter. Does Stoney have any obligation to report the divisional manager's behavior to a superior? Explain.

3. Assume that Stoney refuses to cooperate. However, Keri insists that the changes be made. Now what should Stoney do? What would you do?
4. Suppose that Stoney is 63 years old and that his prospects for employment elsewhere are bleak. Assume again that Keri insists that the changes should be made. Stoney also knows that Keri's superior, the owner of the company, is her father-in-law. Under these circumstances, would your recommendations for Stoney differ? If you were Stoney, what would you do?

6-32 Cyber Research Case

LO1, LO3, LO8

Understanding the nature of process manufacturing helps to understand the nature of process costing. Using an Internet search, find the home pages of one or more cement companies where the processes used to manufacture portland cement are described. Other Internet resources such as an online encyclopedia might also prove to be useful.

Required:

1. Describe in detail each process in the manufacture of portland cement. Now provide a flow diagram that describes the entire manufacturing process from start to finish.
2. Identify the inputs and output(s) of each process.
3. How would you measure the output of each process? Do any of your units of measure change as you go from one process to the next? How would you deal with this change in units when calculating the cost of a unit transferred out to a subsequent process?
4. Do you think that the amount of direct materials that enter the kiln will be the same as the amount that leave it? Explain. How would you deal with the possibility that output is less than the total units of input?
5. Suppose that the output is a 50-pound bag of cement. List all the resources that you can identify that made the manufacture of this product possible.