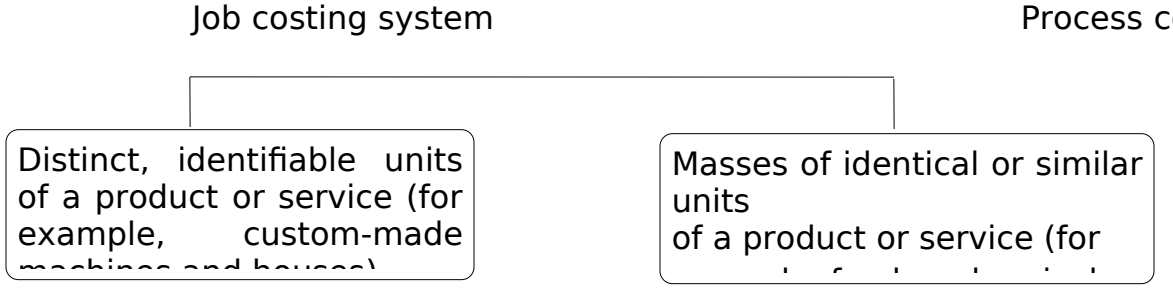
# CHAPTER 4 PROCESS COSTING SYSTEM

Companies that produce identical or similar units of a product or service (for example, an oil-refining company) often use process costing. A key part of process costing is valuing inventory, which entails determining how many units of the product the firm has on hand at the end of an accounting reporting period, evaluating the units' stages of completion, and assigning costs to the units. There are different methods for doing this, each of which can result in different profits.

## Illustrating Process Costing

Before we examine process costing in more detail, let's briefly compare job costing and process costing. Job-costing and process-costing systems are best viewed as ends of a continuum:

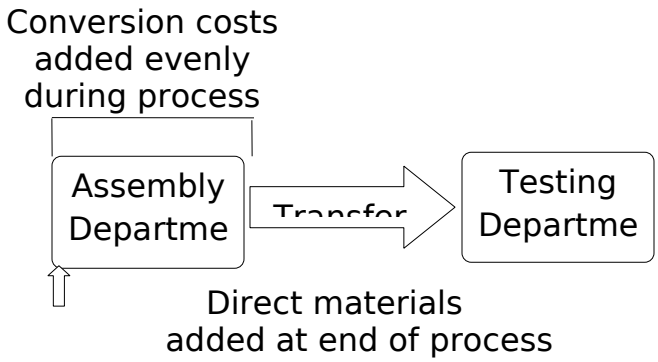



In a *process-costing system*, the unit cost of a product or service is obtained by assigning total costs to many identical or similar units of output. In other words, unit costs are calculated by dividing total costs incurred by the number of units of output from the production process. In a manufacturing process-costing setting, each unit receives the same or similar amounts of direct material costs, direct manufacturing labor costs, and indirect manufacturing costs (manufacturing overhead).

The main difference between process costing and job costing is the *extent of averaging* used to compute unit costs of products or services. In a job-costing system, individual jobs use different quantities of production resources, so it would be incorrect to cost each job at the same average production cost. In contrast, when identical or similar units of products or services are mass-produced, not processed as individual jobs, process costing is used to calculate an average production cost for all units produced. Some processes such as clothes manufacturing have aspects of both process costing (cost per unit of each operation, such as cutting or sewing, is identical) and job costing (different materials are used in different batches of clothing, say, wool versus cotton). The final section in this chapter describes "hybrid" costing systems that combine elements of both job and process costing.

Consider the following illustration of process costing: Suppose that Pacific Electronics manufactures a variety of cell phone models. These models are assembled in the assembly department. Upon completion, units are transferred to the testing department. We focus on the assembly department process for one model, SG-40. All units of SG-40 are identical and must meet a set of demanding performance specifications. The process-costing system for SG-40 in the assembly department has a single direct-cost category – direct materials – and a single indirect-cost category – conversion costs. Conversion costs are all manufacturing costs other than direct material costs, including manufacturing labor, energy, plant depreciation, and so on. Direct materials are added at the beginning of the assembly process. Conversion costs are added evenly during assembly.

The following graphic represents these facts:




Process-costing systems separate costs into cost categories according to *when costs are introduced into the process*. Often, as in our Pacific Electronics example, only two cost classifications – direct materials and conversion costs – are necessary to assign costs to products. Why only two? Because *all* direct materials are added to the process at one time and all conversion costs generally are added to the process evenly through time. If, however, two different direct materials were added to the process at different times, two different direct – materials categories would be needed to assign these costs to products. Similarly, if manufacturing labor costs were added to the process at a different time from when the other conversion costs were added, an additional cost category – direct manufacturing labor costs – would be needed to separately assign these costs to products.

We will use the production of the SG-40 component in the assembly department to illustrate process costing in three cases, starting with the simplest case and introducing additional complexities in subsequent cases:

**Case 1 –** Process costing with zero beginning and zero ending work-in-process inventory of SG-40. (That is, all units are started and fully completed within the accounting period.) *This case presents the most basic concepts of process costing and illustrates the feature of averaging of costs.*

**Case 2 –** Process costing with zero beginning work-in-process inventory and some ending work-in-process inventory of SG-40. (That is, some units of SG-40 started during the accounting period are incomplete at the end of the period.) *This case introduces the five steps of process costing and the concept of equivalent units.*

**Case 3 –** Process costing with both some beginning and some ending work-in-process inventory of SG-40. *This case adds more complexity and illustrates the effect of weighted-average and first-in, first-out (FIFO) cost flow assumptions on cost of units completed and cost of work-in-process inventory.*

## Case 1: Process Costing with No Beginning or Ending Work-in-Process Inventory

On January 1, 2012, there was no beginning inventory of SG-40 units in the assembly department. During the month of January, Pacific Electronics started, completely assembled, and transferred out to the testing department 400 units.

Data for the assembly department for January 2012 are as follows:

**Physical Units for January 2012**

Work in process, beginning inventory 0 units

| | |
|---|---|
| (January 1) | |
| Started during January | 400 units |
| Completed and transferred out during January | 400 units |
| Work in process, ending inventory (January 31) | 0 units |

Physical units refer to the number of output units, whether complete or incomplete. In January 2012, all 400 physical units started were completed.

| **Total Costs for January 2012** | |
|---|---|
| Direct material costs added during January | $32,000 |
| Conversion costs added during January | 24,000 |
| Total assembly department costs added during January | $56,000 |

Pacific Electronics records direct material costs and conversion costs in the assembly department as these costs are incurred. By averaging, assembly cost of SG-40 is $56,000 / 400 units = $140 per unit, itemized as follows:

| | |
|---|---|
| Direct material cost per unit ($32,000 / 400 units) | $80 |
| Conversion cost per unit ($24,000 / 400 units) | 60 |
| Assembly department cost per unit | $140 |

Case 1 shows that in a process-costing system, average unit costs are calculated by dividing total costs in a given accounting period by total units produced in that period. Because each unit is identical, we assume all units receive the same amount of direct material costs and conversion costs. Case 1 applies whenever a company produces a homogeneous product or service but has no incomplete units when each accounting period ends, which is a common situation in service-sector organizations. For example, a bank can adopt this process-costing approach to compute the unit cost of processing 100,000 customer deposits, each similar to the other, made in a month.

**Case 2: Process Costing with Zero Beginning and Some Ending Work-in-Process Inventory**

In February 2012, Pacific Electronics places another 400 units of SG-40 into production. Because all units placed into production in January were completely assembled, there is no beginning inventory of partially completed units in the assembly department on February 1. Some customers order late, so not all units started in February are completed by the end of the month. Only 175 units are completed and transferred to the testing department.

Data for the assembly department for February 2012 are as follows:

| | **Physical Units (SG-40s) (1)** | **Direct Materials (2)** | **Conversion Costs (3)** | **Total Costs (4) = (2) + (3)** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Work in process, beginning inventory (February 1) | 0 | | | |
| Started during February | 400 | | | |
| Completed and transferred out during February | 175 | | | |
| Work in process, ending inventory (February 29) | 225 | | | |
| Degree of completion of ending work in process | | 100% | 60% | |
| Total costs added during February | | $32,000 | $18,600 | $50,600 |

The 225 partially assembled units as of February 29, 2012, are fully processed with respect to direct materials, because all direct materials in the assembly department are added at the beginning of the assembly process. Conversion costs, however, are added evenly during assembly. Based on the work completed relative to the total work required to complete the SG-40 units still in process at the end of February, an assembly department supervisor estimates that the partially assembled units are, on average, 60% complete with respect to conversion costs.

The accuracy of the completion estimate of conversion costs depends on the care, skill, and experience of the estimator and the nature of the conversion process. Estimating the degree of completion is usually easier for direct material costs than for conversion costs, because the quantity of direct materials needed for a completed unit and the quantity of direct materials in a partially completed unit can be measured more accurately. In contrast, the conversion sequence usually consists of a number of operations, each for a specified period of time, at various steps in the production process. The degree of completion for conversion costs depends on the proportion of the total conversion costs needed to complete one unit (or a batch of production) that has already been incurred on the units still in process. It is a challenge for management accountants to make this estimate accurately.

Because of these uncertainties, department supervisors and line managers – individuals most familiar with the process – often make conversion cost estimates. Still, in some industries, such as semiconductor manufacturing, no exact estimate is possible; in other settings, such as the textile industry, vast quantities in process make the task of estimation too costly. In these cases, it is necessary to assume that all work in process in a department is complete to some preset degree with respect to conversion costs (for example, one – third, one – half, or two – thirds complete).

*The point to understand here is that a partially assembled unit is not the same as a fully assembled unit.* Faced with some fully assembled units and some partially assembled units, we require a common metric that will enable us to compare the work done in each category and, more important, obtain a total measure of work done. The concept we will use in this regard is that of *equivalent units*. We will explain this notion in greater detail next as part of the set of five steps required to calculate (1) the cost of fully assembled units in February 2012 and (2) the cost of partially assembled units still in process at the end of that month, for Pacific Electronics. The five steps of process costing are as follows:

**Step 1:** Summarize the flow of physical units of output.

**Step 2:** Compute output in terms of equivalent units.
**Step 3:** Summarize total costs to account for.
**Step 4:** Compute cost per equivalent unit.
**Step 5:** Assign total costs to units completed and to units in ending work in process.

**Physical Units and Equivalent Units (Steps 1 and 2)**
**Step 1** tracks physical units of output. Recall that physical units are the number of output units, whether complete or incomplete. Where did physical units come from? Where did they go? The physical-units column of Exhibit 4 – 1 tracks where the physical units came from (400 units started) and where they went (175 units completed and transferred out, and 225 units in ending inventory). Remember, when there is no opening inventory, units started must equal the sum of units transferred out and ending inventory.

Because not all 400 physical units are fully completed, output in **Step 2** is computed in *equivalent units*, not in *physical units*. To see what we mean by equivalent units, let's say that during a month, 50 physical units were started but not completed by the end of the month. These 50 units in ending inventory are estimated to be 70% complete with respect to conversion costs. Let's examine those units from the perspective of the conversion costs already incurred to get the units to be 70% complete. Suppose we put all the conversion costs represented in the 70% into making fully completed units. How many units could have been 100% complete by the end of the month? The answer is 35 units. Why? Because 70% of conversion costs incurred on 50 incomplete units could have been incurred to make 35 (0.70 x 50) complete units by the end of the month. That is, if all the conversion-cost input in the 50 units in inventory had been used to make completed output units, the company would have produced 35 completed units (also called *equivalent units*) of output.

**Exhibit 4 – 1 Steps 1 and 2: Summarize Output in Physical Units and Compute Output in Equivalent Units for Assembly Department of Pacific Electronics for February 2012**

| Flow of Production | (Step 1) | (Step 2) | |
|---|---|---|---|
| | | Equivalent Units | |
| | Physical Units (SG-40s) (1) | Direct Materials (2) | Conversion Costs (3) |
| Work in process, beginning | 0 | | |
| Started during current period | 400 | | |
| To account for | 400 | | |
| Completed and transferred out during current period | 175 | 175 | 175 |
| Work in process, ending[a] | 225 | | |
| (225 × 100%; 225 × 60%) | | 225 | 135 |
| Accounted for | 400 | | |
| Equivalent units of work done in current | | 400 | 310 |

| | | | |
|---|---|---|---|
| period | | | |
| [a]Degree of completion in this department; direct materials, 100%; conversion costs, 60%. | | | |

**Equivalent units** is a derived amount of output units that (1) takes the quantity of each input (factor of production) in units completed and in incomplete units of work in process and (2) converts the quantity of input into the amount of completed output units that could be produced with that quantity of input. Note that equivalent units are calculated separately for each input (such as direct materials and conversion costs). Moreover, every completed unit, by definition, is composed of one equivalent unit of each input required to make it. This chapter focuses on equivalent – unit calculations in manufacturing settings.

Equivalent-unit concepts are also found in nonmanufacturing settings. For example, universities convert their part-time student enrollments into "full-time student equivalents."

*When calculating equivalent units in Step 2, focus on quantities. Disregard dollar amounts until after equivalent units are computed.* In the Pacific Electronics example, all 400 physical units – the 175 fully assembled units and the 225 partially assembled units – are 100% complete with respect to direct materials because all direct materials are added in the assembly department at the start of the process. Therefore, Exhibit 4 – 1 shows output as 400 *equivalent units* for direct materials: 175 equivalent units for the 175 physical units assembled and transferred out, and 225 equivalent units for the 225 physical units in ending work-in-process inventory.

The 175 fully assembled units are also completely processed with respect to conversion costs. The partially assembled units in ending work in process are 60% complete (on average). Therefore, conversion costs in the 225 partially assembled units are *equivalent* to conversion costs in 135 (60% of 225) fully assembled units. Hence, Exhibit 4 – 1 shows output as 310 *equivalent units* with respect to conversion costs: 175 equivalent units for the 175 physical units assembled and transferred out and 135 equivalent units for the 225 physical units in ending work-in-process inventory.

**Calculation of Product Costs (Steps 3, 4, and 5)**

Exhibit 4 – 2 shows Steps 3, 4, and 5. Together, they are called the production cost worksheet.

**Step 3** summarizes total costs to account for. Because the beginning balance of work – in process inventory is zero on February 1, total costs to account for (that is, the total charges or debits to the Work in Process – Assembly account) consist only of costs added during February: direct materials of $32,000 and conversion costs of $18,600, for a total of $50,600.

**Step 4** in Exhibit 4 – 2 calculates cost per equivalent unit separately for direct materials and for conversion costs by dividing direct material costs and conversion costs added during February by the related quantity of equivalent units of work done in February (as calculated in Exhibit 4 – 1).

To see the importance of using equivalent units in unit-cost calculations, compare conversion costs for January and February 2012. Total conversion costs of $18,600 for the 400 units worked on during February are lower than the conversion costs of $24,000

for the 400 units worked on in January. However, in this example, the conversion costs to fully assemble a unit are $60 in both January and February. Total conversion costs are lower in February because fewer equivalent units of conversion-costs work were completed in February (310) than in January (400). Using physical units instead of equivalent units in the per-unit calculation would have led to the erroneous conclusion that conversion costs per unit declined from $60 in January to $46.50 ($18,600 ÷ 400 units) in February. This incorrect costing might have prompted Pacific Electronics to presume that greater efficiencies in processing had been achieved and to lower the price of SG-40, for example, when in fact costs had not declined.

**Step 5** in Exhibit 4 – 2 assigns these costs to units completed and transferred out and to units still in process at the end of February 2012. The idea is to attach dollar amounts to the equivalent output units for direct materials and conversion costs of (a) units completed and (b) ending work in process, as calculated in Exhibit 4 – 1, Step 2. *Equivalent output units for each input are multiplied by cost per equivalent unit, as calculated in Step 4 of Exhibit 4 – 2*. For example, costs assigned to the 225 physical units in ending work-in-process inventory are as follows:

| | |
|---|---|
| Direct material costs of 225 equivalent units (Exhibit 4 – 1, Step 2) x<br>$80 cost per equivalent unit of direct materials calculated in Step 4 | $18,000 |
| Conversion costs of 135 equivalent units (Exhibit 4 – 1, Step 2) x<br>$60 cost per equivalent unit of conversion costs calculated in Step 4 | 8,100 |
| Total cost of ending work – in – process inventory | $26,100 |

Note that total costs to account for in Step 3 ($50,600) equal total costs accounted for in Step 5.

**Exhibit 4 – 2** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process for Assembly Department of Pacific Electronics for February 2012

| | | **Total Production Costs** | **Direct Materials** | **Conversion Costs** |
|---|---|---|---|---|
| **(Step 3)** | Costs added during February | $50,600 | $32,000 | $18,600 |
| | Total costs to account for | $50,600 | $32,00 | $18,600 |

| | | | | |
|---|---|---|---|---|
| | | | 0 | |
| **(Step 4)** | Costs added in current period | $50,600 | $32,000 | |
| | Divide by equivalent units of work done in current period (Exhibit 4 – 1) | ÷ 400 | ÷ 310 | |
| | Cost per equivalent unit | $ 80 | $ 60 | |
| **(Step 5)** | Assignment of costs: | | | |
| | Completed and transferred out (175 units) | $24,500 | (175a × $80) | (175a × $60) |
| | Work in process, ending(225 units): | 26,100 | (225[b] × $80) | + (135[b] × $60) |
| | Total costs accounted for | $50,600 | $32,000 | + $18,600 |

[a] Equivalent units completed and transferred out from Exhibit 4 – 1, step 2.
[b] Equivalent units in ending work in process from Exhibit 4 – 1, step 2.

**Journal Entries**

Journal entries in process-costing systems are similar to the entries made in job-costing systems with respect to direct materials and conversion costs. The main difference is that, in process costing, there is one Work in Process account for each process. In our example, there are accounts for Work in Process – Assembly and Work in Process – Testing. Pacific Electronics purchases direct materials as needed. These materials are delivered directly to the assembly department. Using amounts from Exhibit 4 – 2, summary journal entries for February are as follows:

1. Work in Process – Assembly 32,000
   Accounts Payable Control 32,000
   To record direct materials purchased and used in production during February.
2. Work in Process – Assembly 18,600
   Various accounts such as Wages Payable Control and Accumulated Depreciation 18,600
   To record conversion costs for February; examples include energy, manufacturing supplies, all manufacturing labor, and plant depreciation.
3. Work in Process – Testing 24,500
   Work in Process – Assembly 24,500
   To record cost of goods completed and transferred from assembly to testing during February.

Exhibit 4 – 3 shows a general framework for the flow of costs through T-accounts. Notice how entry 3 for $24,500 follows the physical transfer of goods from the assembly to the testing department. The T-account Work in Process – Assembly shows February 2012's ending balance of $26,100, which is the beginning balance of Work in Process – Assembly in March 2012. It is important to ensure that all costs have been accounted for and that the ending inventory of the current month is the beginning inventory of the following month.

**Case 3: Process Costing with Some Beginning and Some Ending Work-in-Process Inventory**

At the beginning of March 2012, Pacific Electronics had 225 partially assembled SG-40 units in the assembly department. It started production of another 275 units in March.

Data for the assembly department for March are as follows:

| | **Physical Units (SG-40s) (1)** | **Direct Materials (2)** | **Conversion Costs (3)** | **Total Costs (4) = (2) + (3)** |
|---|---|---|---|---|
| Work in process, beginning inventory (March 1) | 225 | $18,000[a] | $8,100[a] | $26,100 |
| Degree of completion of beginning work in process | | 100% | 60% | |
| Started during March | 275 | | | |
| Completed and transferred out during March | 400 | | | |
| Work in process, ending inventory (March 31) | 100 | 100% | 50% | |
| Degree of completion of ending work in process | | | | |
| Total costs added during March | | $19,800 | $16,380 | $36,180 |
| [a]Work in process, beginning inventory (equals work in process, ending inventory for February)<br>Conversion costs: 225 physical units × 60% completed × $60 per unit = $8,100<br>Direct materials: 225 physical units × 100% completed × $80 per unit = $18,000 | | | | |

Pacific Electronics now has incomplete units in both beginning work-in-process inventory and ending work-in-process inventory for March 2012. We can still use the five steps described earlier to calculate (1) cost of units completed and transferred out and (2) cost of ending work in process. To assign costs to each of these categories, however, we first need to choose an inventory-valuation method. We next describe the five-step approach for two important methods – the *weighted – average method* and the *first – in, first – out method*. These different valuation methods produce different amounts for cost of units completed and for ending work in process when the unit cost of inputs changes from one period to the next.

**Weighted-Average Method**

The **weighted-average process – costing method** calculates cost per equivalent unit of all *work done to date* (regardless of the accounting period in which it was done) and

assigns this cost to equivalent units completed and transferred out of the process and to equivalent units in ending work-in-process inventory. The weighted – average cost is the total of all costs entering the Work in Process account (whether the costs are from beginning work in process or from work started during the current period) divided by total equivalent units of work done to date. We now describe the weighted-average method using the five – step procedures.

**Step 1: Summarize the Flow of Physical Units of Output.** The physical-units column of Exhibit 4 – 4 shows where the units came from – 225 units from beginning inventory and 275 units started during the current period – and where they went – 400 units completed and transferred out and 100 units in ending inventory.

**Step 2: Compute Output in Terms of Equivalent Units.** The weighted-average cost of inventory is calculated by merging together the costs of beginning inventory and the manufacturing costs of a period and dividing by the total number of units in beginning inventory and units produced during the accounting period. We apply the same concept here except that calculating the units – in this case equivalent units – is done differently. We use the relationship shown in the following equation:

Equivalent units in beginning work in process + Equivalent units of work done in current period
=
Equivalent units completed and transferred out in current period + Equivalent units in ending work in process

Although we are interested in calculating the left-hand side of the preceding equation, it is easier to calculate this sum using the equation's right-hand side: (1) equivalent units completed and transferred out in the current period plus (2) equivalent units in ending work in process. *Note that the stage of completion of the current-period beginning work in process is not used in this computation.*

The equivalent-units columns in Exhibit 4 – 4 show equivalent units of work done to date: 500 equivalent units of direct materials and 450 equivalent units of conversion costs. All completed and transferred-out units are 100% complete as to both direct materials and conversion costs. Partially completed units in ending work in process are 100% complete as to direct materials because direct materials are introduced at the beginning of the process, and 50% complete as to conversion costs, based on estimates made by the assembly department manager.

**Step 3: Summarize Total Costs to Account For.** Exhibit 4 – 5 presents Step 3. Total costs to account for in March 2012 are described in the example data on page 615: beginning work in process, $26,100 (direct materials, $18,000, plus conversion costs, $8,100), plus costs added during March, $36,180 (direct materials, $19,800, plus conversion costs, $16,380). The total of these costs is $62,280.

**Step 4: Compute Cost per Equivalent Unit.** Exhibit 4 – 5, Step 4, shows the computation of weighted-average cost per equivalent unit for direct materials and conversion costs. Weighted-average cost per equivalent unit is obtained by dividing the sum of costs for beginning work in process plus costs for work done in the current period by total equivalent units of work done to date. When calculating weighted-average conversion cost per equivalent unit in Exhibit 4 – 5, for example, we divide total

conversion costs, $24,480 (beginning work in process, $8,100, plus work done in current period,
$16,380), by total equivalent units of work done to date, 450 (equivalent units of conversion costs in beginning work in process and in work done in current period), to obtain weighted-average cost per equivalent unit of $54.40.

**Exhibit 4 – 5** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process Using Weighted – Average Method of Process Costing for Assembly Department of Pacific Electronics for March 2012

| | | **Total Production Costs** | **Direct Materials** | **Conversion Costs** |
|---|---|---|---|---|
| **(Step 3)** | Work in process, beginning | $26,100 | $18,000 | $ 8,100 |
| | Costs added in current period | 36,180 | 19,800 | 16,380 |
| | Total costs to account for | $50,600 | $37,800 | $24,480 |
| | | | | |
| **(Step 4)** | Costs incurred to date | $37,800 | $24,480 | |
| | Divide by equivalent units of work done to date (Exhibit 4 – 4) | ÷ 500 | ÷ 450 | |
| | Cost per equivalent unit of work done to date | $ 75.60 | $ 54.40 | |
| | | | | |
| **(Step 5)** | Assignment of costs: | | | |
| | Completed and transferred out (400 units) | $52,000 | (400[a] × $75.60) | (400a × $54.40) |
| | Work in process, ending(100 units): | 10,280 | (100[b] × $75.60) | + (100[b] × $54.40) |
| | Total costs accounted for | $62,280 | $37,800 | + $24,480 |

[a] Equivalent units completed and transferred out from Exhibit 4 – 4, step 2.
[b] Equivalent units in ending work in process from Exhibit 4 – 4, step 2.

**Step 5: Assign Total Costs to Units Completed and to Units in Ending Work in Process.** Step 5 in Exhibit 4 – 5 takes the equivalent units completed and transferred out and equivalent units in ending work in process calculated in Exhibit 4 – 4, Step 2, and assigns dollar amounts to them using the weighted-average cost per equivalent unit for direct materials and conversion costs calculated in Step 4. For example, total costs of the 100 physical units in ending work in process are as follows:

| | |
|---|---|
| Direct materials:<br>100 equivalent units x weighted-average cost per equivalent unit of $75.60 | $ 7,560 |
| Conversion costs:<br>50 equivalent units x weighted-average cost per equivalent unit of $54.40 | 2,720 |
| Total costs of ending work in process | $10,2 |

| | |
|---|---|
| | 80 |

The following table summarizes total costs to account for ($62,280) and how they are accounted for in Exhibit 4 – 5. The arrows indicate that the costs of units completed and transferred out and units in ending work in process are calculated using weighted-average total costs obtained after merging costs of beginning work in process and costs added in the current period.

| **Costs to Account For** | | | **Costs Accounted for Calculated on a Weighted-Average Basis** | |
|---|---|---|---|---|
| Beginning work in process | $26,100 | → | Completed and transferred out | $52,000 |
| Costs added in current period | 36,180 | → | Ending work in process | 10,280 |
| Total costs to account for | $62,280 | | Total costs accounted for | $62,280 |

*Before proceeding, review Exhibits 4 – 4 and 4 – 5 to check your understanding of the weighted-average method. Note: Exhibit 4 – 4 deals with only physical and equivalent units, not costs. Exhibit 4 – 5 shows the cost amounts.*

Using amounts from Exhibit 4 – 5, the summary journal entries under the weighted average method for March 2012 at Pacific Electronics are as follows:

1. Work in Process – Assembly 19,800
   Accounts Payable Control 19,800
   To record direct materials purchased and used in production during March.
2. Work in Process – Assembly 16,380
   Various accounts such as Wages Payable Control and Accumulated Depreciation 16,380
   To record conversion costs for March; examples include energy, manufacturing supplies, all manufacturing labor, and plant depreciation.
3. Work in Process – Testing 52,000
   Work in Process – Assembly 52,000
   To record cost of goods completed and transferred from assembly to testing during March.

The T-account Work in Process – Assembly, under the weighted-average method, is as follows:

Work in Process – Assembly

| | | | |
|---|---|---|---|
| Beginning inventory, March 1 | 26,100 | Completed and transferred out to Work in Process - Testing | 52,000 |

| | |
|---|---|
| Direct materials | 16,380 |
| Conversion costs | 16,380 |
| Ending inventory, March 31 | 10,280 |

**First-In, First-Out Method**

The **first-in, first-out (FIFO) process-costing method** (1) assigns the cost of the previous accounting period's equivalent units in beginning work-in-process inventory to the first units completed and transferred out of the process, and (2) assigns the cost of equivalent units worked on during the *current* period first to complete beginning inventory, next to start and complete new units, and finally to units in ending work-in-process inventory. The FIFO method assumes that the earliest equivalent units in work in process are completed first.

*A distinctive feature of the FIFO process-costing method is that work done on beginning inventory before the current period is kept separate from work done in the current period.* Costs incurred and units produced in the current period are used to calculate cost per equivalent unit of work done in the current period. In contrast, equivalent-unit and cost per – equivalent – unit calculations under the weighted-average method *merge* units and costs in beginning inventory with units and costs of work done in the current period.

We now describe the FIFO method using the five – step procedure.

**Step 1: Summarize the Flow of Physical Units of Output.** Exhibit 4 – 6, Step 1, traces the flow of physical units of production. The following observations help explain the calculation of physical units under the FIFO method for Pacific Electronics.

- The first physical units assumed to be completed and transferred out during the period are 225 units from beginning work-in-process inventory.
- The March data indicate that 400 physical units were completed during March. The FIFO method assumes that of these 400 units, 175 units (400 units 225 units from beginning work-in-process inventory) must have been started and completed during March.
- Ending work-in-process inventory consists of 100 physical units – the 275 physical units started minus the 175 units that were started and completed.
- The physical units "to account for" equal the physical units "accounted for" (500 units).

**Step 2: Compute Output in Terms of Equivalent Units.** Exhibit 4 – 6 also presents the computations for Step 2 under the FIFO method. *The equivalent – unit calculations for each cost category focus on equivalent units of work done in the current period (March) only.*

Under the FIFO method, equivalent units of work done in March on the beginning work – in – process inventory equal 225 physical units times *the percentage of work remaining to be done in March to complete these units*: 0% for direct materials, because beginning work in process is 100% complete with respect to direct materials, and 40% for conversion costs, because beginning work in process is 60% complete with respect to conversion costs. The results are 0 (0% 225) equivalent units of work for direct materials

and 90 (40% 225) equivalent units of work for conversion costs. The equivalent units of work done on the 175 physical units started and completed equals 175 units times 100% for both direct materials and conversion costs, because all work on these units is done in the current period.

The equivalent units of work done on the 100 units of ending work in process equal 100 physical units times 100% for direct materials (because all direct materials for these units are added in the current period) and 50% for conversion costs (because 50% of the conversion-costs work on these units is done in the current period).

**Step 3: Summarize Total Costs to Account For.** Exhibit 4 – 7 presents Step 3 and summarizes total costs to account for in March 2012 (beginning work in process and costs added in the current period) of $62,280.

**Step 4: Compute Cost per Equivalent Unit.** Exhibit 17-7 shows the Step 4 computation of cost per equivalent unit for *work done in the current period only* for direct materials and conversion costs. For example, conversion cost per equivalent unit of $52 is obtained by dividing current-period conversion costs of $16,380 by current-period conversion costs equivalent units of 315.

**Step 5: Assign Total Costs to Units Completed and to Units in Ending Work in Process.**

Exhibit 4 – 7 shows the assignment of costs under the FIFO method. Costs of work done in the current period are assigned (1) first to the additional work done to complete the beginning

**Exhibit 4 – 6** Steps 1 and 2: Summarize Output in Physical Units and Compute Output in Equivalent Units Using FIFO Method of Process Costing for Assembly Department of Pacific Electronics for March 2012

| | **(Step 1)** | **(Step 2)** | |
|---|---|---|---|
| | | **Equivalent Units** | |
| **Flow of Production** | **Physical Units (SG-40s) (1)** | **Direct Materials (2)** | **Conversion Costs (3)** |
| Work in process, beginning | 225 | | |
| Started during current period | 275 | | |
| To account for | 500 | | |
| Completed and transferred out during | | | |

| | | | |
|---|---|---|---|
| current period: | | | |
| From beginning work in process[a] | 225 | | |
| [225 × (100% – 100%); 225 × (100% – 60%)] | | 0 | 90 |
| Started and completed | 175[b] | | |
| (175 × 100%; 175 × 100%) | | 175 | 175 |
| Work in process, ending[c] | 100 | | |
| (100 × 100%; 100 × 50%) | | 100 | 50 |
| Accounted for | 500 | | |
| Equivalent units of work done in current period | | 275 | 315 |
| [a]Degree of completion in this department; direct materials, 100%; conversion costs, 60%. | | | |
| [b]400 physical units completed and transferred out minus 225 physical units completed and transferred out from beginning work-in-process inventory. | | | |
| [c]Degree of completion in this department: direct materials, 100%; conversion costs, 50%. | | | |

work in process, then (2) to work done on units started and completed during the current period, and finally (3) to ending work in process. *Step 5 takes each quantity of equivalent units calculated in Exhibit 4 – 6, Step 2, and assigns dollar amounts to them (using the cost – per – equivalent – unit calculations in Step 4).* The goal is to use the cost of work done in the current period to determine total costs of all units completed from beginning inventory and from work started and completed in the current period, and costs of ending work in process.

Of the 400 completed units, 225 units are from beginning inventory and 175 units are started and completed during March. The FIFO method starts by assigning the costs of beginning work-in-process inventory of $26,100 to the first units completed and transferred out. As we saw in Step 2, an additional 90 equivalent units of conversion costs are needed to complete these units in the current period. Current-period conversion cost per equivalent unit is $52, so $4,680 (90 equivalent units x $52 per equivalent unit) of additional costs are incurred to complete beginning inventory. Total production costs for units in beginning inventory are $26,100 = $4,680 + $30,780. The 175 units started and completed in the current period consist of 175 equivalent units of direct materials and 175 equivalent units of conversion costs. These units are costed at the cost per equivalent unit in the current period (direct materials, $72, and conversion costs, $52) for a total production cost of $21,700 [175 x ($72 + $52)].

**Exhibit 4 – 7** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process Using FIFO Method of Process Costing for Assembly Department of Pacific Electronics for March 2012

| | | Total Production Costs | Direct Materials | Conversion Costs |
|---|---|---|---|---|
| **(Step 3)** | Work in process, beginning | $26,100 | $18,000 | $ 8,100 |
| | Costs added in current period | 36,180 | 19,800 | 16,380 |
| | Total costs to account for | $62,280 | $37,800 | $24,480 |
| | | | | |
| **(Step 4)** | Costs added in current period | 36,180 | 19,800 | |
| | Divide by equivalent units of work done in current period (Exhibit 4 – 6) | ÷ 275 | ÷ 315 | |
| | Cost per equivalent unit of work done to date | $ 72 | $ 52 | |
| | | | | |
| **(Step 5)** | Assignment of costs: | | | |
| | Completed and transferred out (400 units): | | | |
| | Work in process, beginning (225 units) | $26,100 | $18,000 | + $8,100 |
| | Costs added to beginning work in process in current period | 4,680 | (0[a] × $72) | + (90[a] × $52) |
| | Total from beginning inventory | 30,780 | | |
| | Started and completed (175 units) | 21,700 | (175[b] × $72) | + (175[b] × $52) |
| | Total costs of units completed and transferred out | $52,480 | | |
| | Work in process, ending (100 units): | 9,800 | (100[c] × $72) | + (50c × $52) |
| | Total costs accounted for | $62,280 | $37,800 | + $24,480 |

[a]Equivalent units used to complete beginning work in process from Exhibit 4 – 6, Step 2.
[b]Equivalent units started and completed from Exhibit 4 – 6, Step 2.
[c]Equivalent units in ending work in process from Exhibit 4 – 6, Step 2.

Under FIFO, ending work – in – process inventory comes from units that were started but not fully completed during the current period. Total costs of the 100 partially assembled physical units in ending work in process are as follows:

| | |
|---|---|
| Direct materials:<br>100 equivalent units x $72 cost per equivalent unit in March | $7,200 |
| Conversion costs:<br>50 equivalent units x $52 cost per equivalent unit in March | 2,600 |
| Total cost of work in process on March 31 | $9,800 |

The following table summarizes total costs to account for and costs accounted for of $62,280 in Exhibit 4 – 7. Notice how under the FIFO method, the layers of beginning work in process and costs added in the current period are kept separate. The arrows indicate

where the costs in each layer go—that is, to units completed and transferred out or to ending work in process. Be sure to include costs of beginning work in process ($26,100) when calculating costs of units completed from beginning inventory.

| Costs to Account For | | | Costs Accounted for Calculated on a FIFO Basis | |
|---|---|---|---|---|
| | | → | Completed and transferred out | |
| Beginning work in process | $26,100 | → | Beginning work in process | $26,100 |
| Costs added in current period | 36,180 | → | Used to complete beginning work in process | 10,280 |
| | | → | Started and completed | 21,700 |
| | | | Completed and transferred out | 0 |
| | | | | 52,480 |
| | | | Ending work in process | 9,800 |
| Total costs to account for | $62,280 | | Total costs accounted for | $62,280 |

*Before proceeding, review Exhibits 4 – 6 and 4 – 7 to check your understanding of the FIFO method. Note: Exhibit 4 – 6 deals with only physical and equivalent units, not costs. Exhibit 4 – 7 shows the cost amounts.*

The journal entries under the FIFO method are identical to the journal entries under the weighted-average method except for one difference. The entry to record the cost of goods completed and transferred out would be $52,480 under the FIFO method instead of $52,000 under the weighted-average method.

**Comparison of Weighted – Average and FIFO Methods**

Consider the summary of the costs assigned to units completed and to units still in process under the weighted-average and FIFO process-costing methods in our example for March 2012:

| | Weighted Average (from Exhibit 4 – 5) | FIFO (from Exhibit 4 – 7) | Difference |
|---|---|---|---|
| Cost of units completed and transferred out | $52,000 | $52,480 | + $480 |
| Work in process, ending | 10,280 | 9,800 | - $480 |
| Total costs accounted for | $62,280 | $62,280 | |

The weighted-average ending inventory is higher than the FIFO ending inventory by $480 or 4.9% ($480 /$9,800 = 0.049, or 4.9%). This would be a significant difference when aggregated over the many thousands of products that Pacific Electronics makes. When completed units are sold, the weighted-average method in our example leads to a lower cost of goods sold and, therefore, higher operating income and higher income taxes than the FIFO method. To see why the weighted-average method yields a lower cost of units completed. Direct material cost per equivalent unit in beginning work – in process inventory is $80, and conversion cost per equivalent unit in beginning work – in process inventory is $60. These costs are greater, respectively, than the $72 direct materials cost and the $52 conversion cost per equivalent unit of work done during the

current period. The current-period costs could be lower due to a decline in the prices of direct materials and conversion-cost inputs, or as a result of Pacific Electronics becoming more efficient in its processes by using smaller quantities of inputs per unit of output, or both.

For the assembly department, FIFO assumes that (1) all the higher-cost units from the previous period in beginning work in process are the first to be completed and transferred out of the process and (2) ending work in process consists of only the lower-cost current-period units. The weighted-average method, however, smooths out cost per equivalent unit by assuming that (1) more of the lower-cost units are completed and transferred out and (2) some of the higher – cost units are placed in ending work in process. The decline in the current – period cost per equivalent unit results in a lower cost of units completed and transferred out and a higher ending work-in-process inventory under the weighted-average method compared with FIFO.

Cost of units completed and, hence, operating income can differ materially between the weighted-average and FIFO methods when (1) direct material or conversion cost per equivalent unit varies significantly from period to period and (2) physical-inventory levels of work in process are large in relation to the total number of units transferred out of the process. As companies move toward long-term procurement contracts that reduce differences in unit costs from period to period and reduce inventory levels, the difference in cost of units completed under the weighted-average and FIFO methods will decrease.

Managers use information from process-costing systems to aid them in pricing and product – mix decisions and to provide them with feedback about their performance. FIFO provides managers with information about changes in costs per unit from one period to the next. Managers can use this information to adjust selling prices based on current conditions (for example, based on the $72 direct material cost and $52 conversion cost in March). They can also more easily evaluate performance in the current period compared with a budget or relative to performance in the previous period (for example, recognizing the decline in both unit direct material and conversion costs relative to the prior period). By focusing on work done and costs of work done during the current period, the FIFO method provides useful information for these planning and control purposes.

The weighted – average method merges unit costs from different accounting periods, obscuring period-to-period comparisons. For example, the weighted-average method would lead managers at Pacific Electronics to make decisions based on the $75.60 direct materials and $54.40 conversion costs, rather than the costs of $72 and $52 prevailing in the current period. Advantages of the weighted-average method, however, are its relative computational simplicity and its reporting of a more-representative average unit cost when input prices fluctuate markedly from month to month.

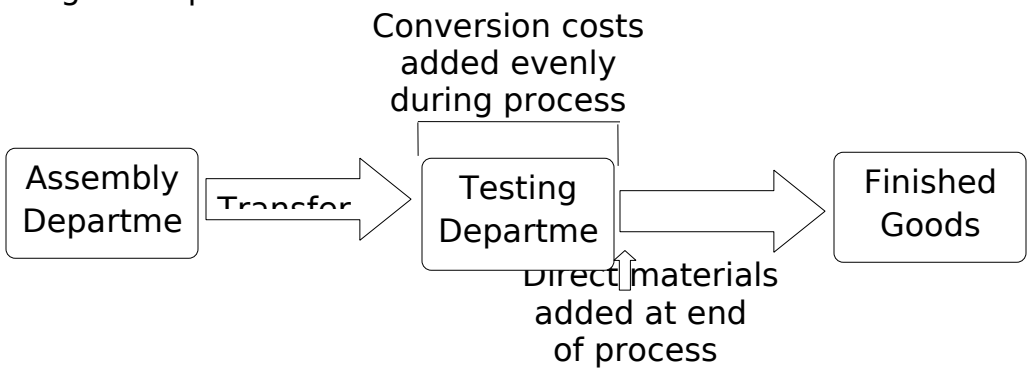
Activity-based costing plays a significant role in our study of job costing, but how is activity – based costing related to process costing? Each process – assembly, testing, and so on – can be considered a different (production) activity. However, no additional activities need to be identified within each process. That’s because products are homogeneous and use resources of each process in a uniform way. The bottom line is that activity-based costing has less applicability in process-costing environments.

**Transferred-In Costs in Process Costing**

Many process-costing systems have two or more departments or processes in the production cycle. As units move from department to department, the related costs are also transferred by monthly journal entries. **Transferred-in costs** (also called **previous-department costs**) are costs incurred in previous departments that are carried forward as the product's cost when it moves to a subsequent process in the production cycle.

We now extend our Pacific Electronics example to the testing department. As the assembly process is completed, the assembly department of Pacific Electronics immediately transfers SG-40 units to the testing department. Conversion costs are added evenly during the testing department's process. At the ***end of the process*** in testing, units receive additional direct materials, including crating and other packing materials to prepare units for shipment. As units are completed in testing, they are immediately transferred to Finished Goods. Computation of testing department costs consists of transferred-in costs, as well as direct materials and conversion costs that are added in testing.

The following diagram represents these facts:




*Transferred-in costs are treated as if they are a separate type of direct material added at the beginning of the process.* That is, transferred-in costs are always 100% complete as of the beginning of the process in the new department. When successive departments are involved, transferred units from one department become all or a part of the direct materials of the next department; however, they are called transferred-in costs, not direct material costs.

| | **Physical Units (SG – 40s)** | **Transferred-In Costs** | **Direct Materials** | **Conversion Costs** |
|---|---|---|---|---|
| Work in process, beginning inventory (March 1) | 240 | $33,600 | $ 0 | $18,000 |
| Degree of completion of beginning | | 100% | 0% | 62.5% |

| | | | | |
|---|---|---|---|---|
| work in process | | | | |
| Transferred in during March | 400 | | | |
| Completed and transferred out during March | 440 | | | |
| Work in process, ending inventory (March 31) | 200 | | | |
| Degree of completion of ending work in process | | 100% | 0% | 80% |
| Total costs added during March | | | | |
| Direct materials and conversion costs | | | $13,200 | $48,600 |
| Transferred in (Weighted-average ) | | $52,000 | | |
| Transferred in (FIFO ) | | $52,480 | | |

**Transferred – In Costs and the Weighted-Average Method**

To examine the weighted-average process-costing method with transferred-in costs, we use the five – step procedure described earlier to assign costs of the testing department to units completed and transferred out and to units in ending work in process.

Exhibit 4 – 8 shows Steps 1 and 2. The computations are similar to the calculations of equivalent units under the weighted-average method for the assembly department in Exhibit 4 – 4. The one difference here is that we have transferred – in costs as an additional input. All units, whether completed and transferred out during the period or in ending work in process, are always fully complete with respect to transferred-in costs. The reason is that the transferred-in costs refer to costs incurred in the assembly department, and any units received in the testing department must have first been completed in the assembly department. However, direct material costs have a zero degree of completion in both beginning and ending work-in-process inventories because, in testing, direct materials are introduced at the *end* of the process.

Exhibit 4 – 9 describes Steps 3, 4, and 5 for the weighted-average method. Beginning work in process and work done in the current period are combined for purposes of computing cost per equivalent unit for transferred-in costs, direct material costs, and conversion costs.

The journal entry for the transfer from testing to Finished Goods (see Exhibit 4 – 9) is as follows:

| | | |
|---|---|---|
| Finished Goods Control | 120,890 | |
| Work in Process – Testing | | 120,890 |
| To record cost of goods completed and transferred from testing to Finished Goods. | | |

Entries in the Work in Process – Testing account (see Exhibit 4 – 9) are as follows:

Work in Process – Testing

| | | | |
|---|---|---|---|
| Beginning inventory, | 51,60 | Transferred | 120,890 |

| | | |
|---|---|---|
| March 1 | 0 | out |
| Transferred – in costs | 52,000 | |
| Direct materials | 13,200 | |
| Conversion costs | 48,600 | |
| Ending inventory, March 31 | 44,510 | |

**Exhibit 4 – 8** Steps 1 and 2: Summarize Output in Physical Units and Compute Output in Equivalent Units Using Weighted-Average Method of Process Costing for Testing Department of Pacific Electronics for March 2012

| Flow of Production | Step 1 | Step 2 | | |
|---|---|---|---|---|
| | | Equivalent Units | | |
| | Physical Units (SG – 40s) | Transferred-In Costs | Direct Materials | Conversion Costs |
| Work in process, beginning inventory (March 1) | 240 | | | |
| Transferred in during March | 400 | | | |
| To account for | 640 | | | |
| Completed and transferred out during March | 440 | 440 | 440 | 440 |
| Work in process, ending inventory (March 31)[a] | 200 | | | |
| (200 × 100%; 200 × 0%; 200 × 80%) | | 200 | 0 | 160 |
| Accounted for | 640 | | | |
| Equivalent units of work done to date | | 640 | 440 | 600 |

[a] Degree of completion in this department; transferred – in costs, 100%; direct materials, 0%; conversion costs, 80%.

**Exhibit 4 – 9** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process Using Weighted – Average Method of Process Costing for Testing Department of Pacific Electronics for March 2012

| | | Total Production Costs | Transferred-In Costs | Direct Materials | Conversion Costs |
|---|---|---|---|---|---|
| **(Step 3)** | Work in process, beginning | $51,600 | $33,600 | $ 0 | $18,000 |

| | | | | | |
|---|---|---|---|---|---|
| | Costs added in current period | 113,800 | 52,000 | 13,200 | 48,600 |
| | Total costs to account for | $165,400 | 85,600 | $13,200 | $66,600 |
| | | | | | |
| **(Step 4)** | Costs incurred to date | | $85,600 | $13,200 | $66,600 |
| | Divide by equivalent units of work done to date (Exhibit 4 – 8) | | ÷ 640 | ÷ 440 | ÷ 600 |
| | Cost per equivalent unit of work done to date | | $ 133.75 | $ 30.00 | $ 111.00 |
| | | | | | |
| **(Step 5)** | Assignment of costs: | | | | |
| | Completed and transferred out (440 units) | $120,890 | (440[a] × $133.75) | (440[a] × $30) | (440[a] × $111) |
| | Work in process, ending(200 units): | 44,510 | (200[b] × $133.75) | (0[b] × $30) | (160[b] × $111) |
| | Total costs accounted for | $165,400 | $85,600 | $13,200 | $66,600 |
| [a]Equivalent units completed and transferred out from Exhibit 4 – 8, Step 2.<br>[b] Equivalent units in ending work in process from Exhibit 4 – 8, Step 2. | | | | | |

**Transferred-In Costs and the FIFO Method**

To examine the FIFO process-costing method with transferred-in costs, we again use the five – step procedure. Exhibit 4 – 10 shows Steps 1 and 2. Other than considering transferred – in costs, computations of equivalent units are the same as under the FIFO method for the assembly department shown in Exhibit 4 – 6.

Exhibit 4 – 11 describes Steps 3, 4, and 5. In Step 3, total costs to account for of $165,880 under the FIFO method differs from the corresponding amount under the weighted – average method of $165,400. The reason is the difference in cost of completed units transferred in from the assembly department under the two methods – $52,480 under FIFO and $52,000 under weighted average. Cost per equivalent unit for the current period in Step 4 is calculated on the basis of costs transferred in and work done in the current period only. Step 5 then accounts for the total costs of $165,880 by assigning them to the units transferred out and those in ending work in process. Again, other than considering transferred – in costs, the calculations mirror those under the FIFO method for the assembly department shown in Exhibit 4 – 7.

Remember that in a series of interdepartmental transfers, each department is regarded as separate and distinct for accounting purposes. The journal entry for the transfer from testing to Finished Goods (see Exhibit 4 – 11) is as follows:

| | | |
|---|---|---|
| Finished Goods Control | 122,360 | |
| Work in Process – Testing | | 122,360 |
| To record cost of goods completed and transferred from testing | | |

to Finished Goods.

**Exhibit 4 – 10** Steps 1 and 2: Summarize Output in Physical Units and Compute Output in Equivalent Units Using FIFO Method of Process Costing for Testing Department of Pacific Electronics for March 2012

| Flow of Production | Step 1 | Step 2 | | |
|---|---|---|---|---|
| | | Equivalent Units | | |
| | Physical Units (SG – 40s) | Transferred-In Costs | Direct Materials | Conversion Costs |
| Work in process, beginning inventory (March 1) | 240 | (work done before current period) | | |
| Transferred in during March | 400 | | | |
| To account for | 640 | | | |
| Completed and transferred out during March: | | | | |
| From beginning work in process[a] | 240 | | | |
| [240 × (100% – 100%); 240 × (100% – 0%); 240 × (100% – 62.5%)] | | 0 | 240 | 90 |
| Started and completed | 200[b] | | | |
| (200 × 100%; 200 × 100%; 200 × 100%) | | 200 | 200 | 200 |
| Work in process, ending inventory (March 31)[c] | 200 | | | |
| (200 × 100%; 200 × 0%; 200 × 80%) | | 200 | 0 | 160 |
| Accounted for | 640 | | | |
| Equivalent units of work done in current period | | 400 | 440 | 450 |

[a]Degree of completion in this department: transferred-in costs, 100%; direct materials, 0%; conversion costs, 62.5%.
[b]440 physical units completed and transferred out minus 240 physical units completed and transferred out from beginning work-in-process inventory.
[c]Degree of completion in this department: transferred-in costs, 100%; direct materials, 0%; conversion costs, 80%.

**Exhibit 4 – 11** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process Using FIFO Method of Process Costing for Testing Department of Pacific Electronics for March 2012

| | | Total Production Costs | Transferred-In Costs | Direct Materials | Conversion Costs |
|---|---|---|---|---|---|
| **(Step 3)** | Work in process, beginning | $51,600 | $33,600 | $ 0 | $18,000 |
| | Costs added in current period | 114,280 | 52,480 | 13,200 | 48,600 |
| | Total costs to account for | $165,880 | 86,080 | $13,200 | $66,600 |
| | | | | | |
| **(Step 4)** | Costs added in current period | | 52,480 | 13,200 | 48,600 |
| | Divide by equivalent units of work done in current period (Exhibit 4 – 10) | | ÷ 400 | ÷ 440 | ÷ 450 |
| | Cost per equivalent unit of work done in current period | | $ 131.20 | $ 30.00 | $ 108.00 |
| | | | | | |
| **(Step 5)** | Assignment of costs: | | | | |
| | Completed and transferred out (440 units) | | | | |
| | Work in process, beginning (240 units) | $ 51,600 | $33,600 | $ 0 | $18,000 |
| | Costs added to beginning work in process in current period | 16,920 | ([a] × $131.20) | (240[a] × $30) | (90[a] × $108) |
| | Total from beginning inventory | 68,520 | | | |
| | Started and completed (200 units) | 53,840 | (200[b] × $131.20) | (200[b] × $30) | (200[b] × $108) |
| | Total costs of units completed and transferred out | 122,360 | | | |
| | Work in process, ending(200 units): | 43,520 | (200[c] × $131.20) | (0[c] × $30) | (160[c] × $108) |
| | Total costs accounted for | $165,880 | $86,080 | $13,200 | $66,600 |

[a]Equivalent units used to complete beginning work in process from Exhibit 4 – 10, Step 2.
[b]Equivalent units started and completed from Exhibit 4 – 10, Step 2.
[c]Equivalent units in ending work in process from Exhibit 4 – 10, Step 2.

Entries in the Work in Process – Testing account (see Exhibit 4 – 11) are as follows:

Work in Process – Testing

| | | | |
|---|---|---|---|
| Beginning inventory, March 1 | 51,600 | Transferred out | 122,360 |

| | |
|---|---|
| Transferred – in costs | 52,480 |
| Direct materials | 13,200 |
| Conversion costs | 48,600 |
| Ending inventory, March 31 | 43,520 |

**Points to Remember About Transferred – In Costs**

Some points to remember when accounting for transferred-in costs are as follows:

1. Be sure to include transferred – in costs from previous departments in your calculations.
2. In calculating costs to be transferred on a FIFO basis, do not overlook costs assigned in the previous period to units that were in process at the beginning of the current period but are now included in the units transferred. For example, do not overlook the $51,600 in Exhibit 4 – 11.
3. Unit costs may fluctuate between periods. Therefore, transferred units may contain batches accumulated at different unit costs. For example, the 400 units transferred in at $52,480 in Exhibit 17-11 using the FIFO method consist of units that have different unit costs of direct materials and conversion costs when these units were worked on in the assembly department (see Exhibit 4 – 7). Remember, however, that when these units are transferred to the testing department, they are costed at *one average unit cost* of $131.20 ($52,480 /400 units), as in Exhibit 4 – 11.
4. Units may be measured in different denominations in different departments. Consider each department separately. For example, unit costs could be based on kilograms in the first department and liters in the second department. Accordingly, as units are received in the second department, their measurements must be converted to liters.

**Standard – Costing Method of Process Costing**

**Benefits of Standard Costing**

Companies that use process-costing systems produce masses of identical or similar units of output. In such companies, it is fairly easy to set standards for quantities of inputs needed to produce output. Standard cost per input unit can then be multiplied by input quantity standards to develop standard cost per output unit.

The weighted-average and FIFO methods become very complicated when used in process industries that produce a wide variety of similar products. For example, a steel – rolling mill uses various steel alloys and produces sheets of various sizes and finishes. The different types of direct materials used and the operations performed are few, but used in various combinations, they yield a wide variety of products. Similarly, complex conditions are frequently found, for example, in plants that manufacture rubber products, textiles, ceramics, paints, and packaged food products. In each of these cases, if the broad averaging procedure of *actual* process costing were used, the result would be inaccurate costs for each product. Therefore, the standard – costing method of process costing is widely used in these industries.

Under the standard – costing method, teams of design and process engineers, operations personnel, and management accountants work together to determine *separate* standard costs per equivalent unit on the basis of different technical processing specifications for each product. Identifying standard costs for each product overcomes the disadvantage of costing all products at a single average amount, as under actual costing.

**Computations Under Standard Costing**

We return to the assembly department of Pacific Electronics, but this time we use standard costs. Assume the same standard costs apply in February and March of 2012. Data for the assembly department are as follows:

| | **Physical Units (SG-40s) (1)** | **Direct Materials (2)** | **Conversion Costs (3)** | **Total Costs (4) = (2) + (3)** |
|---|---|---|---|---|
| Standard cost per unit | | $74 | $54 | |
| Work in process, beginning inventory (March 1) | 225 | | | |
| Degree of completion of beginning work in process | | 100% | 60% | |
| Beginning work in process inventory at standard costs | | $16,650[a] | $ 7,290[a] | $23,940 |
| Started during March | 275 | | | |
| Completed and transferred out during March | 400 | | | |
| Work in process, ending inventory (March 31) | 100 | | | |
| Degree of completion of ending work in process | | 100% | 50% | |
| Actual total costs added during March | | $19,800 | $16,380 | $36,180 |

[a]Work in process, beginning inventory at standard costs
Conversion costs: 225 physical units × 60% completed × $54 per unit = $7,290
Direct materials: 225 physical units × 100% completed × $74 per unit = $16,650

We illustrate the standard-costing method of process costing using the five-step procedure introduced earlier.

Exhibit 4 – 12 presents Steps 1 and 2. These steps are identical to the steps described for the FIFO method in Exhibit 4 – 6 because, as in FIFO, the standard-costing method also assumes that the earliest equivalent units in beginning work in process are completed first. Work done in the current period for direct materials is 275 equivalent units. Work done in the current period for conversion costs is 315 equivalent units.

**Exhibit 4 – 12** Steps 1 and 2: Summarize Output in Physical Units and Compute Output in Equivalent Units Using Standard-Costing Method of Process Costing for Assembly Department of Pacific Electronics for March 2012

| Flow of Production | (Step 1) | (Step 2) | |
|---|---|---|---|
| | | Equivalent Units | |
| | Physical Units (SG-40s) (1) | Direct Materials (2) | Conversion Costs (3) |
| Work in process, beginning | 225 | | |
| Started during current period | 275 | | |
| To account for | 500 | | |
| Completed and transferred out during current period: | | | |
| From beginning work in process[a] | 225 | | |
| [225 × (100% – 100%); 225 × (100% – 60%)] | | 0 | 90 |
| Started and completed | 175[b] | | |
| (175 × 100%; 175 × 100%) | | 175 | 175 |
| Work in process, ending[c] | 100 | | |
| (100 × 100%; 100 × 50%) | | | |
| Accounted for | 500 | 100 | 50 |
| Equivalent units of work done in current period | | 275 | 315 |

[a]Degree of completion in this department: direct materials, 100%; conversion costs, 60%.
[b]400 physical units completed and transferred out minus 225 physical units completed and transferred out from beginning work-in-process inventory.
[c]Degree of completion in this department: direct materials, 100%; conversion costs, 50%.

**Exhibit 4 – 13** Steps 3, 4, and 5: Summarize Total Costs to Account For, Compute Cost per Equivalent Unit, and Assign Total Costs to Units Completed and to Units in Ending Work in Process Using Standard – Costing Method of Process Costing for Assembly Department of Pacific Electronics for March 2012

| | | **Total Production Costs** | **Direct Materials** | **Conversion Costs** |
|---|---|---|---|---|
| **(Step 3)** | Work in process, beginning | | | |
| | Direct materials, 225 × $74; Conversion costs, 135 × $54 | $23,940 | $16,650 | $7,290 |
| | Costs added in current period at standard costs | | | |
| | Direct materials, 275 × $74; Conversion costs, 315 × $54 | 37,360 | 20,350 | 17,010 |
| | Total costs to account for | $61,300 | $37,000 | $24,300 |
| | | | | |
| **(Step 4)** | Standard cost per equivalent unit | | $74 | $54 |
| | | | | |
| **(Step 5)** | Assignment of costs: | | | |
| | Completed and transferred out (400 units): | | | |
| | Work in process, beginning (225 units) | $23,940 | $16,650 | + $7,290 |
| | Costs added to beginning work in process in current period | 4,840 | (0[a] × $74) | + (90[a] × $54) |
| | Total from beginning inventory | 28,800 | | |
| | Started and completed (175 units) | 22,400 | (175[b] × $74) | + (175[b] × $54) |
| | Total costs of units completed and transferred out | $51,200 | | |
| | Work in process, ending (100 units): | 10,100 | (100[c] × $74) | + (50c × $54) |
| | Total costs accounted for | $61,300 | $37,000 | + $24,300 |
| Summary of variances for current performance: | | | | |
| Costs added in current period at standard costs (see step 3) | | | $20,350 | $17,010 |
| Actual costs incurred | | | $19,800 | $16,380 |
| Variance | | | $ 550(F) | $ 630(F) |

[a]Equivalent units used to complete beginning work in process from Exhibit 4 – 12, Step 2.
[b]Equivalent units started and completed from Exhibit 4 – 12, Step 2.
[c]Equivalent units in ending work in process from Exhibit 4 – 12, Step 2.

Exhibit 4 – 13 describes Steps 3, 4, and 5. In Step 3, total costs to account for (that is, the total debits to Work in Process – Assembly) differ from total debits to Work in Process – Assembly under the actual – cost – based weighted – average and FIFO methods. That's

because, as in all standard-costing systems, the debits to the Work in Process account are at standard costs, rather than actual costs. These standard costs total $61,300 in Exhibit 4 – 13. In Step 4, costs per equivalent unit are standard costs: direct materials, $74, and conversion costs, $54. *Therefore, costs per equivalent unit do not have to be computed as they were for the weighted-average and FIFO methods.*

Exhibit 4 – 13, Step 5, assigns total costs to units completed and transferred out and to units in ending work – in process inventory, as in the FIFO method. Step 5 assigns amounts of standard costs to equivalent units calculated in Exhibit 4 – 12. These costs are assigned (1) first to complete beginning work-in-process inventory, (2) next to start and complete new units, and (3) finally to start new units that are in ending work-in-process inventory. Note how the $61,300 total costs accounted for in Step 5 of Exhibit 4 – 13 equal total costs to account for.

**Hybrid Costing Systems**

Product – costing systems do not always fall neatly into either job-costing or process-costing categories. Consider Ford Motor Company. Automobiles may be manufactured in a continuous flow (suited to process costing), but individual units may be customized with a special combination of engine size, transmission, music system, and so on (which requires job costing). A **hybrid – costing system** blends characteristics from both job-costing and process costing systems. Product – costing systems often must be designed to fit the particular characteristics of different production systems. Many production systems are a hybrid: They have some features of custom-order manufacturing and other features of mass-production manufacturing. Manufacturers of a relatively wide variety of closely related standardized products (for example, televisions, dishwashers, and washing machines) tend to use hybrid – costing systems. The next section explains *operation costing*, a common type of hybrid costing system.

**Overview of Operation – Costing Systems**

An **operation** is a standardized method or technique that is performed repetitively, often on different materials, resulting in different finished goods. Multiple operations are usually conducted within a department. For instance, a suit maker may have a cutting operation and a hemming operation within a single department. The term *operation*, however, is often used loosely. It may be a synonym for a department or process. For example, some companies may call their finishing department a finishing process or a finishing operation.

An **operation – costing system** is a hybrid-costing system applied to batches of similar, but not identical, products. Each batch of products is often a variation of a single design, and it proceeds through a sequence of operations. Within each operation, all product units are treated exactly alike, using identical amounts of the operation's resources. A key point in the operation system is that each batch does not necessarily move through the same operations as other batches. Batches are also called production runs.

In a company that makes suits, management may select a single basic design for every suit to be made, but depending on specifications, each batch of suits varies somewhat from other batches. Batches may vary with respect to the material used or the type of

stitching. Semiconductors, textiles, and shoes are also manufactured in batches and may have similar variations from batch to batch.

An operation – costing system uses work orders that specify the needed direct materials and step – by – step operations. Product costs are compiled for each work order. Direct materials that are unique to different work orders are specifically identified with the appropriate work order, as in job costing. However, each unit is assumed to use an identical amount of conversion costs for a given operation, as in process costing.
A single average conversion cost per unit is calculated for each operation, by dividing total conversion costs for that operation by the number of units that pass through it. This average cost is then assigned to each unit passing through the operation. Units that do not pass through an operation are not allocated any costs of that operation. Our examples assume only two cost categories – direct materials and conversion costs – but operation costing can have more than two cost categories. Costs in each category are identified with specific work orders using job-costing or process costing methods as appropriate.

Managers find operation costing useful in cost management because operation costing focuses on control of physical processes, or operations, of a given production system. For example, in clothing manufacturing, managers are concerned with fabric waste, how many fabric layers that can be cut at one time, and so on. Operation costing measures, in financial terms, how well managers have controlled physical processes.