Chapter 4

Accumulating and Assigning Costs to Products

After completing this chapter, you will be able to:

1. Describe the cost flows that take place in manufacturing, service, and retail organizations.
2. Understand the concepts of direct and indirect costs and appropriately classify a cost using these concepts.
3. Develop indirect cost rates for applying overhead costs to products.
4. Evaluate a cost system to determine whether it is likely to distort product costs.
5. Recognize how product and process characteristics define the appropriate structure of a costing system.
6. Design and interpret basic job order and process costing systems.
7. Understand the methods of allocating service department costs to production departments.

Strict's Custom Framing

Strict's Custom Framing provides high-end portrait framing. A large bank, which requires framed portraits of its senior-level managers, has approached Dana Strict, Strict's owner and president, for a quote to supply approximately 400 framed photographs over the next five years.

As part of the process of preparing a quote for the bank, Dana has asked Enid Pierce, the Strict's Customer Framing Controller, to prepare a cost estimate. Enid's preliminary research provided the following information. A professional portrait photographer will supply a photograph, approved by the client, for $700 per manager. The bank will contract with the photographer and pay this cost directly to the photographer.

The bank has specified a standard size and framing materials for all the portraits. The cost of framing materials including the wood frame

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stock, glass, mat, glue, backing, hardware used to hang the finished product, and the plaque engraved with each manager's name will be $350 per portrait. Enid is certain about the costs of these materials since they would be supplied under a fixed price contract by Strict's current suppliers. Strict's staff has packaged and shipped, via courier, a prototype portrait, and the shipping materials and shipping costs, including insurance, will cost $100 per portrait.

What Enid is not sure about are the other costs required to frame the portraits.

The framing process begins by cutting the wooden frame pieces from the stock provided by the supplier. Workers then assemble the wood frame using a jig, glue, and nails. Once the frame is ready, workers add the portrait, glass, mat, and backing. Finally, workers apply the hardware that is used to hang the portrait.

Enid is also uncertain about whether the other costs of manufacturing the frames, such as machine and labor costs, should be included in her estimate of the cost of each portrait.

IN PRACTICE

On the Importance of Understanding Costs in the Restaurant Business

". . . you have got to get the pricing just right. You cannot afford to overcharge or undercharge. That means knowing exactly how much every dish costs to produce and charging 2.5 times the cost." Attributed to David Adjey, celebrity chef and restaurant consultant, by Leon Goldstein, restaurateur.

Cost Management Systems

In this and the next two chapters, we discuss how cost management systems measure the costs of products, services, and customers. Historically, two cost management systems, job order costing and process costing, have been used to cost products and services. Many companies continue to use these two systems. Since the mid-1980s, however, companies have been adopting activity-based costing for products, customers, and services. Cost management systems differ in the way that they assign indirect costs to cost objects. In this chapter, we focus on the two traditional methods: job order and process costing systems.

Cost Flows in Organizations

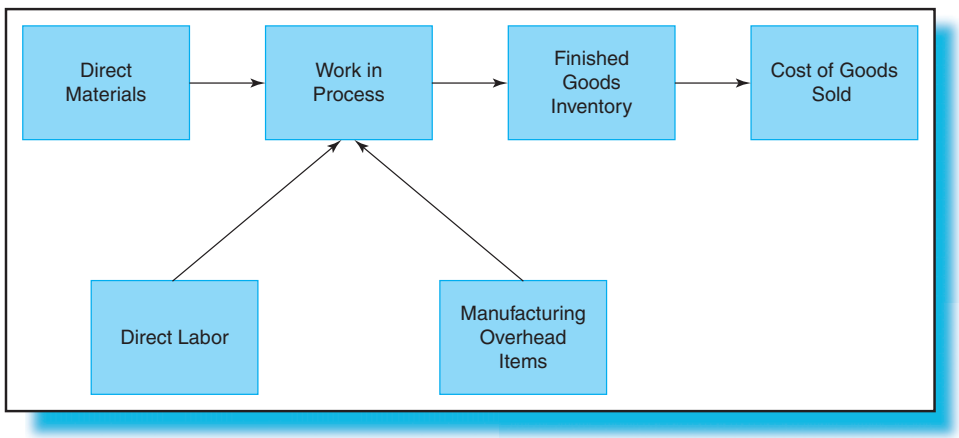
To compute product costs, management accounting systems should reflect the actual cost flows in organizations. Manufacturing, retail, and service organizations have very different patterns of cost flows resulting in different management accounting priorities.

Manufacturing Organizations

Exhibit 4-1 summarizes the manufacturing sequence in a simple organization. Recall from Chapter 3 that manufacturing costs are usually classified into three groups: direct materials, direct labor, and manufacturing overhead. Materials are withdrawn from raw materials inventory as production begins. The cost of the raw materials entered into production is moved from the raw materials account to the work-in-process inventory account. The manufacturing operation consumes labor and overhead items (such as machine time and factory supplies), the cost of which are assigned to production by adding them to the work-in-process inventory account. Overhead costs are assigned (or allocated or apportioned) as determined by the cost system. When manufacturing is completed, work is transferred to **finished goods inventory**, and costs are moved from the work-in-process inventory account to the finished goods inventory account. Finally, when goods are sold their costs are moved from the finished goods inventory account to cost of goods sold.

Although the production and costing process in most organizations is usually much more complex, Exhibit 4-1 provides the basic idea behind all manufacturing

Exhibit 4-1
Cost Flows in a Manufacturing Organization



costing systems: to determine the costs that products accumulate as they consume organization resources during manufacturing. We will come back to Exhibit 4-1 later in this chapter as we discuss manufacturing cost accounting in more detail.

Retail Organizations

Exhibit 4-2 summarizes the flow of activities in a retail organization. As goods are purchased, their cost is entered into an account that accumulates the cost of merchandise inventory in the store. Stores incur various overhead costs such as labor, depreciation on the store, lighting, and heating. The primary focus in retail operations is the profitability of product lines or departments. Therefore, costing attention focuses, as in manufacturing operations, on how to allocate various overhead costs to determine, for example, the cost of purchasing and selling products, or department costs. However, unlike manufacturing operations where manufacturing overhead costs often account for about half of total costs to produce goods, merchandise costs in retail organizations can exceed 80% of total costs to purchase and sell goods. Therefore, the potential for distorting the cost of purchasing and selling products through inappropriate allocations of overhead costs is lower in retail organizations than in manufacturing organizations.

Service Organizations

Exhibit 4-3 summarizes the flow of activities in a service organization that undertakes major projects, such as in a consultancy. Unlike retail operations where the major cost item is merchandise, in service organizations the major cost item is usually employee pay. In such service organizations the focus is on determining the cost of a project. Since salaries and wages often comprise 80% or more of total project-related costs,

Exhibit 4-2
Cost Flows in a Retail Organization

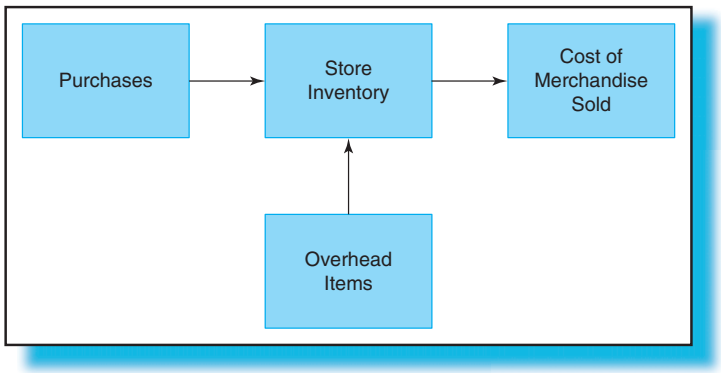
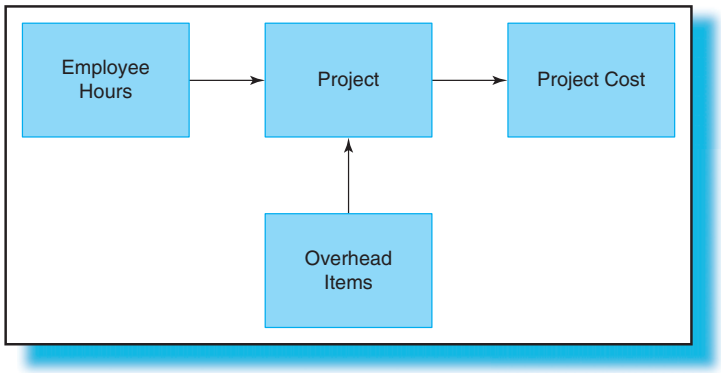


Exhibit 4-3
Cost Flows in a Service Organization



and they can be easily assigned to different projects or services, the potential for cost system distortions in such a service organization is less than in a manufacturing organization. Chapter 6 discusses costing complexities in service contexts where the cost of transacting with an additional customer is small. Examples of such contexts include banking, air travel, and telecommunications.

Because issues surrounding handling production overhead costs are more complex in manufacturing operations, in the following discussions we focus on costing issues in manufacturing organizations. The concepts, tools, and principles of costing in manufacturing organizations also apply in retail and service organizations.

Some Important Cost Terms

Before we develop the key issues in costing we need to develop a few important costing terms that we will use extensively in the discussion that follows.

Cost Object

A **cost object** is anything for which a cost is computed. Examples of cost objects are activities, products, product lines, departments, or even entire organizations.

Consumable Resources

The defining characteristic of a **consumable resource**, also called a **flexible resource**, is that its cost depends on the amount of resource that is used. Examples of consumable resources are wood in a furniture factory and iron ore in a steel mill. The cost of a consumable resource is often called a variable cost because the total cost depends on how much of the resource is consumed.

Capacity-Related Resources

The defining characteristic of a **capacity-related resource** is that its cost depends on the amount of resource capacity that is acquired and not on how much of the capacity is used. As the size of a proposed factory or warehouse increases, the associated capacity-related cost will increase. Examples of capacity-related costs are depreciation on production equipment (the capacity-related resource) and salaries paid to employees (the capacity-related resource) in a consultancy. The cost of a capacity-related resource is often called a fixed cost because the cost of the resource is independent of how much of the resource is used in the short run.

Direct and Indirect Costs

The usual way to proceed in cost classification is to decide whether a cost is direct. If the cost fails the test of being direct it is classified as indirect. A **direct cost** is a cost that is uniquely and unequivocally attributable to a single cost object.

IN PRACTICE

Cost Objects

Most people have experienced cost accumulation for a cost object. If you have had a car serviced, visited a dentist, or ordered from a menu in a restaurant, the services provided to you have been accumulated in some manner to identify the cost of your job.

This printing press provides its owner with the capacity to print newspapers for itself or its clients. The press capacity is defined by the number of hours it is scheduled to operate.
Alamy Images

If a single cost object consumes a consumable resource, the cost of the consumable resource is a direct cost for that cost object. The cost of wood used to make a table in a furniture factory is a direct cost that would be assigned to the table.

It is rare but possible for the cost of a consumable resource to be properly classified as indirect. For example, suppose that a number of different products are shipped to a customer in one truck. The fuel used by the truck is a consumable resource. However, the fuel is jointly used by all of the products being carried in the truck. Therefore, if the cost object is an individual product on board the truck, the cost of the fuel is an indirect cost to that product since all of the products on board the truck jointly consume the fuel.

Any cost that fails the test of being a direct cost is an **indirect cost**. This may sound simple, but disputes in costing about whether a cost (more correctly the resource that created the cost) should be treated as direct or indirect outnumber all other costing disputes.

Most capacity-related costs are indirect. It is unusual for a capacity-related cost to be a direct cost but it is not rare. For example, the cost of production equipment or a factory supervisor that was acquired for and used exclusively by one product is a direct cost for the product. A good test of whether the cost of a capacity resource is indirect is whether the organization would have no use for the resource if the cost object was abandoned.

IN PRACTICE

Indirect Costs

From the time of the Industrial Revolution until the early 20th century, manufacturing operations were mainly labor paced and direct costs comprised the majority of product costs. Since then indirect costs in the form of automation have gradually replaced labor costs and, for many products, are now the major component of total product costs. This increased use of indirect costs in manufacturing has increased the need for costing systems to deal adequately with indirect costs.

In summary, remember that we call the cost of consumable resources variable costs and *almost* all variable costs are direct costs. We call the cost of capacity resources fixed costs and *almost* all fixed costs are indirect costs.

Cost Classification and Context

The classification of a resource (and therefore its cost) as direct or indirect is context specific. Suppose you attend a multiple-campus university. You are a student in the Faculty of Business on one campus. One of your courses is a management accounting course that is offered by the Accounting Department in the Faculty of Business. The course instructor teaches six courses. Let's focus on the salary paid to your management accounting instructor.

If the cost object is the entire university, the university campus, the Faculty of Business, or the Department of Accounting, your instructor's salary is a direct cost. If the cost object is the course you are taking, your instructor's salary is an indirect cost. Why? Because your course is sharing a capacity-related resource (your instructor) with other courses. You might think that an obvious and intuitive approach would be to allocate one-sixth of your instructor's salary to the course you are taking. However, bickering inevitably arises in practice over cost allocations, even ones that seem sensible and intuitive. Exhibit 4-4 provides a summary of common variable and fixed costs and their classifications.

Going Forward

Costing systems first classify costs as direct or indirect. Direct costs are assigned to the appropriate cost object. Indirect costs are allocated to cost objects in a reasonable way, which means that the allocation ideally should reflect the cause-and-effect relationship between the long-run use of a capacity resource by a cost object and the associated cost of that long-run use.

Exhibit 4-4
Attributes of Direct and Indirect Costs

Resource Characteristic	Resource Name	Cost Name	Usual Classification
Consumed by the production process. The total cost of the resource is proportional to the amount of the resource consumed. Examples include: newsprint used to print a paper, plastic used to make laundry hampers, and grain used to make breakfast cereal.	Consumable resource	Variable cost	Direct cost
Provides capacity that is used by the production process. The total cost of the resource is proportional to the amount of the resource that is acquired not how much is used. Examples include: the salary paid to a lawyer, depreciation on factory equipment, and taxes paid on factory property.	Capacity-related resources	Fixed cost	Indirect cost

For the balance of this chapter we will assume that costs that are direct can be reasonably identified and assigned to the appropriate cost object. This assumption allows us to focus on the process of allocating indirect costs to cost objects.

Handling Indirect Costs in a Manufacturing Environment

Exhibit 4-5 reviews what we have done so far. The first step is to classify the cost as direct or indirect. If the cost is direct it is assigned directly to the appropriate cost object. If the cost is indirect, it is assigned to an indirect **cost pool** (there can be one or many). An appropriate portion of the indirect cost is then allocated from the cost pool (or pools) to the cost object (or objects).

We now consider some of the details surrounding the design and use of indirect cost pools.

The simplest structure in a manufacturing system is to have a single indirect cost pool for the entire manufacturing operation. This is the setting depicted in Exhibit 4-1. Examples of indirect costs in a factory setting, which are usually called **fixed manufacturing overhead**, include heating, lighting, depreciation on factory equipment, factory taxes, and supervisory salaries. In the simple costing system shown in Exhibit 4-1, these indirect costs are accumulated in a single indirect cost pool.

Some organizations create another category called **variable overhead**, which includes costs for such items as machine electricity usage, minor materials grouped as **indirect materials** (thread, glue, etc.), and machine supplies. Variable overhead costs are actually direct costs that are too costly and too immaterial (in relation to total product cost) to trace to individual cost objects. An example is the cost of the glue used to make each piece of furniture. These variable costs are accumulated in a variable cost account. Variable overhead costs may be assigned as direct costs. Alternatively, for simplicity, variable overhead costs may be grouped together with fixed

Exhibit 4-5
Costing System Structure

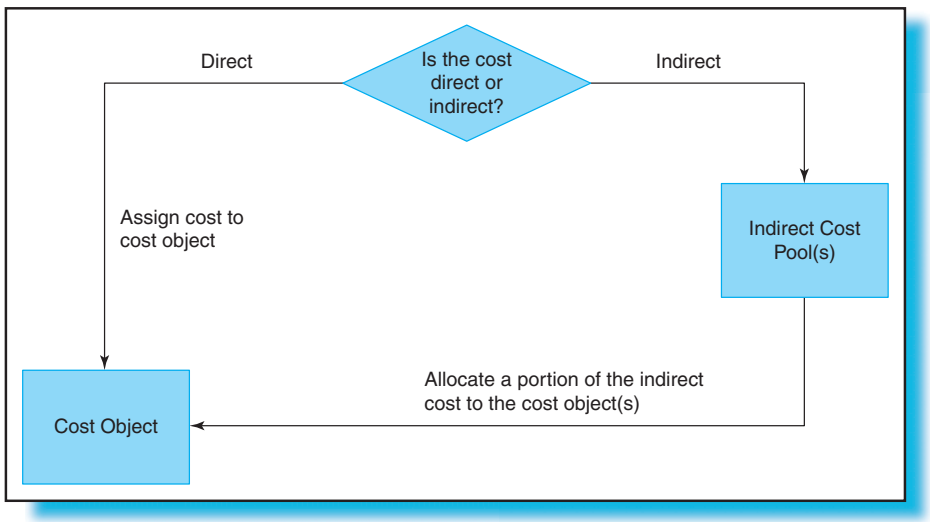
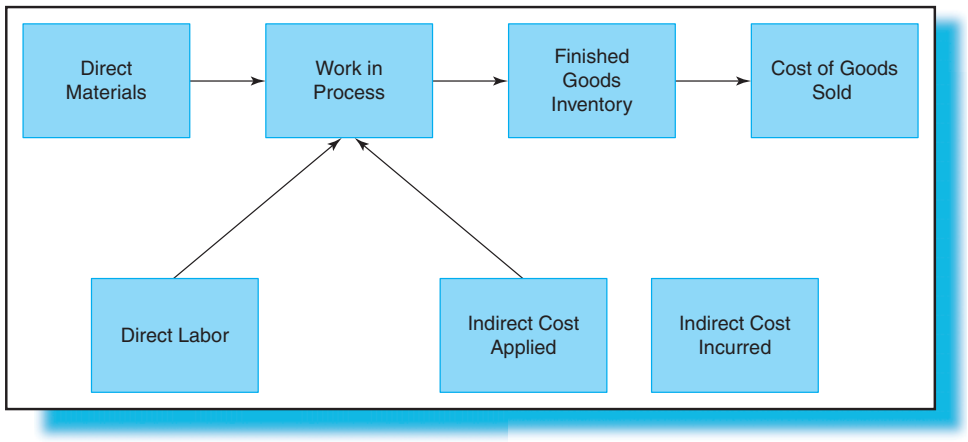


Exhibit 4-6
Cost Flows in a Manufacturing Organization



overhead in developing methods for allocating overhead to cost objects. In this chapter, we maintain the "indirect cost" terminology for overhead to emphasize the challenges in allocating fixed manufacturing overhead to cost objects.

Organizations use a separate account (such as "Indirect Cost Applied" in Exhibit 4-6) to record **applied indirect costs** (that is, indirect costs allocated as production occurs during the year). The resulting situation is shown in Exhibit 4-6, which shows one indirect cost account that accumulates the actual indirect costs that have been incurred, and a second indirect cost account that accumulates the indirect costs that have been applied to production. Later we will discuss the reconciliation between the two accounts, but for now we will focus on how the indirect cost applied account operates.

Because the total indirect costs for the year are not known until after the year end, when all the costs have been accumulated, organizations allocate indirect costs to production during the year using a predetermined indirect cost rate. The first step in developing this rate is to determine the basis, often called the cost driver, which will be used to allocate the indirect cost to production. Cost analysts try to choose a cost driver that best explains the long-run behavior of the indirect cost. In a labor-intensive environment the cost driver of indirect costs in the factory might be labor hours as factory workers use factory space, utilities, and other overhead resources to make products. In a machine-intensive environment the cost driver of indirect costs in the factory might be machine hours because machines consume electricity, lubricants, and other supplies to make products.

Once the cost driver is chosen, cost analysts divide expected indirect factory costs by the number of cost driver units to compute what is called the predetermined indirect cost rate. Other common names for this rate include **predetermined overhead rate** and **cost driver rate**. We use these terms interchangeably in this chapter.

The choice of the number of cost driver units to use to determine the predetermined indirect cost rate is a source of debate. We will sidestep that debate for a moment and assume that the cost driver unit chosen in calculating the predetermined indirect cost rate is the factory's **practical capacity**. We can now compute the predetermined indirect cost rate as follows:

$$\text{predetermined indirect cost rate} = \frac{\text{estimated total factory indirect cost}}{\text{practical capacity in cost driver units}}$$

Exhibit 4-7
Cost Summary for Product X456

	Unit Cost
Direct materials	$27.89
Direct labor (2 hours @ $25.00 per hour)	50.00
Indirect manufacturing cost (2 hours @ $56.00)	112.00
Total manufacturing cost	$189.89

For example, assume that estimated total factory indirect cost at Tim Company is $14,000,000. The cost analyst has decided to use labor hours as the cost driver, and the factory practical capacity expressed in labor hours is 250,000. The predetermined indirect cost rate is $56 (14,000,000/250,000) per direct labor hour. Therefore for every labor hour used in the factory to produce the product, $56 of indirect cost will be applied to the product. This example uses what is called a predetermined plantwide indirect cost rate since a single indirect cost rate is used for the entire factory. Exhibit 4-7 provides a cost summary for Product X456.

Multiple Indirect Cost Pools

Most organizations use multiple indirect cost pools in order to improve costing. Improvement in costing is defined as the ability of the costing system to more accurately reflect the cause-and-effect relationship between the cost object and the cost of the resources used by the cost object.

Many products require a humidity-controlled atmosphere that is free of any airborne particles. These clean rooms are very expensive to build and maintain and their costs should only be allocated to those products that require their use.
Alamy Images

Indirect cost pool design is considered to be one of the most important choices in costing system design and requires a considerable amount of skill and understanding of the manufacturing process in the organization. The two most widely used alternatives for designing multiple indirect cost pools are to base them on organizational units, such as departments, or activities (sometimes processes), such as setup and manufacturing.

We will continue the example at Tim Company to illustrate multiple cost pools designed around organizational units. Production involves two major activities, which are organized into departments: manufacturing and assembly. Workers in the Manufacturing Department enter large pieces of sheet metal into a computer-controlled machine that cuts the sheets of metal into the pieces needed to make the two products.

Workers in the Assembly Department assemble the pieces of metal and undertake finishing operations such as grinding and coating. Machines do most of the work (called a machine-paced operation) in the Manufacturing Department, and workers do most of the work in the Assembly Department (called a labor-paced operation). Mumtaz Khan, the production supervisor at Tim Company, believes that the current system has the potential to distort product costs because the company's two most important products place very different demands on the manufacturing system, as shown in Exhibit 4-8.

The major difference between the two products is that Product X458 is assembled using fewer but much larger pieces than Product X456. Therefore, relative to X456 it takes longer to cut the pieces for X458 in the Machining Department, but less time to assemble them in the Assembly Department.

It is important to remember that costing system distortions relate to the handling of indirect costs. Direct costs are not subject to distortions caused by inappropriate costing system design relating to the handling of indirect costs. Therefore, in the following discussion we will focus only on the treatment of the products' indirect costs.

Suppose that the plant accountant advises that $9,000,000 of the plant's indirect costs are appropriately assigned to the Machining Department and $5,000,000 of the plant's indirect costs are appropriately assigned to the Assembly Department.

The practical capacity of the Machining Department expressed in machine hours (the assumed cost driver in that department) is 30,000 and the practical capacity of the Assembly Department expressed in labor hours (the assumed cost driver in that department) is 200,000. Therefore we can compute the predetermined indirect cost rate for the two departments as follows:

$$\text{predetermined indirect cost rate Machining Department} = \frac{9{,}000{,}000}{30{,}000} = \$300$$

$$\text{predetermined indirect cost rate Assembly Department} = \frac{5{,}000{,}000}{200{,}000} = \$25$$

Exhibit 4-8
Production Requirement for Products X456 and X458

	Product X456		Product X458	
	Machining Department	Assembly Department	Machining Department	Assembly Department
Direct labor hours	0.25	1.75	0.30	0.75
Machine hours	0.15	0.05	0.25	0.06

Exhibit 4-9
Indirect Cost Allocations for Products X456 and X458

Indirect Cost Allocation Product X456	
From machining (0.15 × $300)	$45.00
From assembly (1.75 × $25)	43.75
	$88.75
Indirect Cost Allocation Product X458	
From machining (0.25 × $300)	$75.00
From assembly (0.75 × $25)	18.75
	$93.75

Exhibit 4-9 summarizes the indirect cost allocations resulting from the two-department system.

Note that the indirect cost allocation to Product X458 under the plantwide rate system is $58.80 [(0.30 + 0.75) × $56]. Recalling the earlier calculation of the factory indirect cost allocation to Product X456 in the plantwide rate system, we have the comparative results shown in Exhibit 4-10.

The two-rate system tracks the two products' use of the capacity resources (machine time and labor time) more closely and, therefore, provides a more accurate and meaningful allocation of the costs of the capacity resources the two products use. Note that for Product X458 the allocated indirect cost increases (relative to the plantwide rate approach) because of its heavier consumption of machine time (the more costly resource). For Product X456 the allocated indirect cost drops because it consumed relatively less of the more costly resource.

Cost Pool Homogeneity

Costing distortions can arise when indirect cost pools include costs that have different cost drivers. The following example illustrates this idea.

Cambridge Chemicals

Cambridge Chemicals manufactures two products used for disinfecting sensitive surfaces such as operating theaters in hospitals. The major difference in the two products is that one has an active ingredient that causes the product to have a shelf life of only about 60 days. The other product has virtually unlimited shelf life.

Indirect factory overhead at Cambridge Chemicals amounts to $35,000,000 per accounting period. The factory accountant believes that the practical capacity of the plant is best represented by production volume, which is 2,000,000 liters of product.

Exhibit 4-10
Indirect Cost Allocations Using Plantwide versus Multiple Indirect Rates for Products X456 and X458

	Product X456		Product X458	
	Calculation	Amount	Calculation	Amount
Plantwide system	(.25 + 1.75) × 56	$112.00	(.30 + 75) × 56	$58.80
Multiple indirect rate system	(.15 × 300) + (1.75 × 25)	$88.75	(.25 × 300) + (.75 × 25)	$93.75

Exhibit 4-11
Cambridge Chemicals: Costs Based on Plantwide Overhead Rate

	Product	
	X234	X334
Direct materials	$35.00	$44.50
Direct labor	12.00	14.25
Variable overhead	4.25	6.75
Fixed overhead	17.50	17.50
Total cost	$68.75	$83.00
Price	$137.50	$166.00

This results in a predetermined factory overhead rate of $17.50 ($35,000,000/2,000,000) per liter of product. Exhibit 4-11 summarizes the resulting cost per liter estimate for each product, which was doubled to determine the selling price of each product.

Based on complaints that Product X234 seemed overpriced relative to its competitors and X334 underpriced, a cost study was undertaken. This study revealed that approximately $8,000,000 of the indirect overhead costs relate to providing the capacity for setting up production runs. Setup costs are high because the packaging machines have to be carefully cleaned and disinfected to ensure product integrity. Product X234 is usually produced in batches averaging 10,000 liters, whereas X334 is usually produced in batches averaging 1,000 liters.

With this information in mind, the factory accountant organized the fixed manufacturing overhead into two pools. The first pool of $27,000,000 in costs was allocated based on production volume and the second pool of $8,000,000 was deemed to supply setup capacity amounting to 1,000 batches per period. The predetermined rates for volume-driven and setup-driven overhead were then computed as $13.50 ($27,000,000/2,000,000) and $8,000 ($8,000,000/1,000), respectively. This resulted in the product cost estimates reported in Exhibit 4-12.

This example illustrates the costing distortions that can arise when an indirect cost pool includes costs with different cost drivers and where different products use the capacities underlying the indirect costs differentially. In this case Product X334, a heavy user of setup activities, was being undercosted in the volume-based system because significant costs were being driven by setups and not production volume.

Exhibit 4-12
Cambridge Chemicals: Costs Based on Volume-Driven and Setup-Driven Overhead Rates

	Product	
	X234	X334
Direct materials	$35.00	$44.50
Direct labor	12.00	14.25
Variable overhead	4.25	6.75
Indirect overhead		
Volume driven overhead (1 liter @ $13.50)	13.50	13.50
Setup driven overhead ($8,000/10,000)	0.80	
Setup driven overhead ($8,000/1,000)		8.00
Total cost	$65.55	$87.00
Price (total cost × 2)	$131.10	$174.00

Exhibit 4-13
Job Order Costing at Raul Company

Cost Type	Step 1	Step 2	Step 3
Direct costs			
	Materials 5 units of lumber @ $2.50 per unit	Materials None	Materials 1.5 units of finish @ $3.50 per unit
	Labor 0.5 labor hour @ $22.50 per hour	Labor 0.25 labor hour @ $28.00 per hour	Labor 0.75 labor hour @ $18.00 per hour
Indirect costs			
	Cost driver Labor hours – 0.5 Cost driver rate $11.00 per labor hour	Cost driver Machine hours – 0.15 Cost driver rate $55.00 per machine hour	Cost driver Labor hours Cost driver rate $14.00 per labor hour
Cost calculation			
Materials	$12.50	$0.00	$5.25
Labor	11.25	7.00	13.50
Indirect cost	5.50	8.25	10.50
Total cost	$29.25	$15.25	$29.25
Total product cost	$73.75		

Raul Company

Here is an example that summarizes our work to date.

Raul Company manufactures wooden doors. The manufacturing is done in three steps. In the first step workers glue pieces of wood together to form the door and then trim the door to the required size. In the second step the door is placed on a platform and a computer-controlled router creates the door engraving the customer requires. In the third step the door is treated with the finish specified by the customer and then packed for shipment to the customer. The work in steps 1 and 3 is labor paced and the work in step 2 is machine paced. Each step has its own cost driver and its own cost driver rate.

Exhibit 4-13 summarizes the resource use and the costs for each of the three steps and the total product cost, which is $73.75 ($29.25 + 15.25 + 29.25).

Overhead Allocation: Further Issues

Using Planned Capacity Cost

Earlier we mentioned that cost analysts use the planned, not the actual, level of capacity-related costs in computing the cost driver rate. A number of practical reasons are given for this:

1. The annual actual capacity-related costs are not known until the end of the accounting period (which is usually a year), and cost analysts want to compute costs for cost objects such as customers, products, and jobs before the year end.

IN PRACTICE

Why Costing Matters

The U.S. Defense Department said that it pulled certification for a Lockheed Martin Corp system used to analyze costs for aeronautics programs including the F-35 because of a lack of progress in addressing deficiencies. The Pentagon determined that withdrawal of compliance for Lockheed's "earned value management system" at its Fort Worth, Texas, facility was needed to make sure that the company takes corrective steps in a timely fashion, Defense Department spokesman Cheryl Irwin said in a statement.

Earned value management systems, or EVMS, are used by companies to plan, control, and analyze the cost performance of programs and identify potential overruns. The move comes as the Pentagon looks to end years of massive cost overruns on weapons programs.

Source: Adapted from Reuters, *Update 1—Lockheed Cost-Tracking System Loses Certification*, retrieved October 6, 2010, from http://www.reuters.com/article/idUSN0523484020101005

Reuters Limited

2. Using planned rather than actual capacity-related costs sets a benchmark against which to compare actual capacity-related costs at the end of the accounting period.

Reconciling Actual and Applied Capacity Costs

Recall from the discussion above that to manage a system of allocating indirect costs using a cost driver that is based on planned costs, cost analysts use two cost pools for each capacity-related cost. One pool accumulates the actual capacity-related cost incurred during the period. The second pool accumulates the capacity-related cost that has been applied to production. At the end of the year the balances in the two accounts must be reconciled.

Suppose that Watts Company uses a single indirect cost pool and has estimated capacity-related costs to be $10,000,000 for the year. Watts Company uses the practical capacity of the capacity resource, which is 50,000 machine hours, to compute the cost driver rate of $200 ($10,000,000/50,000) per machine hour.

During the year actual capacity-related costs were $9,500,000, which is the balance in the indirect cost pool that accumulates the actual costs. Production required 45,000 machine hours. The balance in the indirect cost applied cost pool will be $9,000,000 (45,000 × $200). The two accounts must be reconciled, which raises the question of what the cost analyst should do with the $500,000 difference. Note that the actual cost is $500,000 greater than the cost that has been applied to production. The cost analyst has to charge this unallocated actual cost of $500,000 to something.

Option 1: Charge the difference between actual and applied indirect costs to cost of goods sold.

The simplest option is simply to charge the $500,000 to the cost of goods sold in the current period. That is, cost of goods sold is increased by $500,000.

Option 2: Prorate the difference between actual and applied indirect costs to work in process, finished goods, and cost of goods sold.

The second approach is to prorate the $500,000 difference proportionately to the ending balances of work in process, finished goods inventory, and cost of goods sold. For example, if the proportion of applied indirect cost in the ending balances of these accounts this period is 25% in ending work in process, 30% in finished goods inventory, and 45% in cost of goods sold, the $500,000 of costs would be used to increase the balance of **work-in-process inventory**, finished goods inventory, and cost of goods sold by $125,000 (25% × $500,000), $150,000 (30% × $500,000), and $225,000 (45% × $500,000), respectively.

Option 3: Decompose the difference between actual and applied indirect costs into two parts: (1) the difference between actual and budgeted indirect costs and (2) the difference between budgeted and applied indirect costs.

This option is the most complex. However, it focuses on developing information that helps identify the reasons for the difference between actual and applied costs and is, therefore, relevant for internal decision-making purposes.

1. The difference between actual and budgeted indirect costs is −$500,000 ($9,500,000 − $10,000,000) which reflects a favorable indirect cost spending variance. (Recall that in the short run this cost is fixed.) The lower actual cost creates a favorable effect on income, relative to the budgeted cost. The difference would be charged directly to cost of goods sold. Note that this charge would *reduce* the balance of cost of goods sold by $500,000.
2. The difference between budgeted and applied indirect costs is $1,000,000 ($10,000,000 − $9,000,000). This difference results from idle capacity. Recall that the machine hours practical capacity was 50,000, whereas the actual machine hours used totaled 45,000. This means that idle capacity was 5,000 (50,000 − 45,000) machine hours with an associated cost of $1,000,000 (5,000 × $200). This idle capacity cost would be charged directly to cost of goods sold.

The net effect of these two steps would be to increase the balance of cost of goods sold by $500,000 ($1,000,000 − $500,000). Although the net effect is the same as in Option 1, in Option 3 management receives more detailed information on reasons for the difference.

Cost Driver Level

The discussion to date has assumed that the appropriate cost driver level is practical capacity. Practical capacity is one of four commonly proposed activity levels used to compute the cost driver rate. The other three are (1) the actual level of operations, (2) the planned level of operations, and (3) the average level of operations.

Using Actual Costs and Actual Cost Driver Activity

Using the actual level of the cost driver to compute the cost driver rate results in what is called *actual costing* since the rate will be computed after completion of the period and will be computed by dividing the actual capacity-related costs by the actual level

of the cost driver. This approach is advocated by those who believe that all cost allocations should reflect "actual" costs and is, therefore, motivated by the belief that any approach to allocating indirect costs that uses anything other than actual costs and actual cost driver rates will result in distortion of the costs reported in the income statement and the inventory valuations on the balance sheet. It is reasonable to say that most management accountants reject this approach on the grounds that, first, all costs are estimates and, second, using actual costs disguises the managerial insights provided by the other approaches.

Using Planned Cost and the Planned Level of the Cost Driver

Those who advocate computing the cost driver by dividing planned indirect cost by the planned level of the cost driver argue that this approach provides a practical attempt to allocate planned indirect costs and, therefore, provides a practical and appropriate basis for accurate product costing. Proponents of this approach are most concerned with providing what they call "accurate" costs in the income statement and inventory valuations on the balance sheet.

The first objection to this approach is the same as the objection to the actual costing approach mentioned above, namely, that all cost allocations are arbitrary and it is inappropriate to talk about an actual or accurate cost.

The second, and perhaps more important, objection is that the approach makes no economic sense. Whether costs are used for financial reporting or decision making, most observers argue that they should reflect some economic sense. The problem with this approach is that given capacity-related costs that are fixed, when the planned level of production goes down the cost driver rate will increase, causing the product cost to increase. When the planned level of production goes up, the cost driver rate will go down, causing the product cost to decrease. Given that capacity-related costs are driven by the amount of capacity that was acquired rather than what is used, the notion of a varying cost driver rate does not align with the reality that the capacity-related cost is not changing.

The third objection to this approach is the consequence when management uses cost-plus pricing. Note that as expected demand goes down, the cost driver rate will increase, causing the cost-plus price to increase. Increasing prices in the face of falling demand is never a good strategy and can cause what is called a **death spiral**. Increasing prices cause demand to fall, which leads to further price increases as the cost driver rate increases the cost-plus price. Consider also the situation in which a government is contracting with a supplier on a cost-plus basis. No rational government contracting agency would ever agree to increased costs and, therefore, prices driven by the contractor facing a falling demand for capacity.

Using Planned Cost and the Average Level of Activity

On the surface computing a cost driver rate using planned indirect cost and the average level of activity over the capacity's life appears to deal with the problems of the two methods just described. The average use of capacity is, after all, the likely activity rate used to justify the acquisition of the capacity, so this approach would seem to reflect the economic basis for the level and cost of the capacity.

The major problem with this approach is that it buries the cost of idle capacity in product cost and provides no clear incentive for management to increase its use of idle capacity. Moreover if this approach results in computing a product cost that should be compared to the long-run market price needed to support this product, the cost will be illusionary since no customer will pay one supplier more for its product simply because the customer is recovering more of the cost of idle capacity through its price than a competitor that has lower idle capacity costs.

Exhibit 4-14
Texas Metal Works: Theoretical and Practical Capacity

		Hours	% of Theoretical Capacity
Theoretical capacity (weekly)	16 hours per day × 5 days per week	80.00	100.00%
Practical capacity deductions			
Allowance for maintenance	0.45 hours per day × 5 days per week	2.25	2.81%
Setup time loss	1.25 hours per day × 5 days per week	6.25	7.81%
Unscheduled repairs and down time	3.75 hours per week	3.75	4.69%
Lost time due to materials shortage	1.8 hours per week	1.80	2.25%
Total time lost each week		14.05	17.56%
Practical capacity		65.95	82.44%

In conclusion, using practical capacity to estimate product cost provides an approach that is not only practical but provides clear decision-making insights and incentives related to dealing with the cost of idle capacity.

Estimating Practical Capacity

Estimating practical capacity begins with an estimate of theoretical capacity. Suppose a machine is nominally available for 100 hours each week. A common rule of thumb is to set practical capacity equal to 80% of theoretical capacity. In other words, allow about 20% of theoretical capacity or, in this case, 20 hours for activities such as maintenance, setup, and repair.

In the case of labor hired for the year, theoretical capacity is 2,080 hours (52 weeks, 40 hours per week). However, workers on average have 3 weeks off and, with breaks, work about 35 hours per week. Therefore, practical capacity is 1,715 hours (49 weeks, 35 hours per week). In this case practical capacity is about 82% (1,715/2,080) of theoretical capacity.

Texas Metal Works

Texas Metal Works (TMW) uses hydroforming to produce a wide variety of metal parts for its customers. The key resource—and key bottleneck—at TMW is the hydroforming machine, which is scheduled for operation 16 hours per day, five days per week. A study of machine use during the past two years suggests that, on average, this machine requires 0.45 hour of maintenance each day, is idle about 1.25 hours each day while it is being set up, requires about 3.75 hours of repairs per week, and is idled 1.8 hours per week due to materials shortages. Exhibit 4-14 shows that the theoretical capacity of this machine is 80 hours each week and that practical capacity is 65.95 hours each week. Put another way, practical capacity is 82.44% of theoretical capacity.

Job Order and Process Systems

Job Order Costing

Job order costing is an approach to costing that estimates costs for specific customer orders because the orders vary from customer to customer. At an extreme, each product or service may be unique. Examples of situations in which job order costing might

The staff in this dental office will maintain a sheet that summarizes all of the work done on this patient in order to develop a bill for the actual services provided.
Alamy Images

be used include a consulting engagement for a client, building a nuclear reactor for a power utility, providing a meal from a restaurant menu, or treating a patient in a hospital. In each of these cases the organization providing the product or service will typically assign all direct material and direct labor costs to the job. Then the organization will allocate overhead costs to the job using one of the approaches for handling indirect costs that we discussed earlier.

The purpose of the job order costing system is to accumulate the cost of the job because, due to job differences, costs will vary across jobs. Each job will have a cost that is computed by summing the direct and indirect costs of each department or activity that was used to complete the job.

Process Costing

Process costing is an approach to costing that is used when all products are identical. The total cost of all products is determined by adding up all of the direct and indirect costs used to produce the products and then dividing by the number of products produced to get a cost per unit. Examples of products for which process costing is appropriate are soda drinks, breakfast cereal, plastic water bottles, and routine services such as providing influenza inoculations at a medical clinic.

In this setting cost analysts focus on the components of total product cost. Let's look at an example that illustrates a simple process costing environment.

The National Mint

The National Mint manufactures currency and collector coins. The steps to manufacture pure silver collector coins are as follows:

1. *Melting and casting*—Silver is melted and then cast into bars.
2. *Roughing and finishing*—The silver bars are run through a roughing mill and then a finishing mill to produce strips of silver in the width of the coins that will be made.
3. *Blanking*—The silver strips are run through a blanking machine that punches out blank disks that will be used to make the coins.
4. *Rimming*—The blank disks are put through a rimming machine that puts rims on the blank disks.
5. *Annealing*—Several times during the manufacturing process the blank disks are heated, a process called annealing, to make them less brittle.
6. *Cleaning*—The disks are put through a cleaning tub where they are mixed with water and abrasives to smooth and polish them.
7. *Coin press*—The disks are put into a coin press where they are simultaneously punched on the top and bottom to create the coin. This stamping is done twice.

Each of these seven steps is a process that is required to make the silver collector coins. Cost analysts will accumulate the costs of each process in order to compute the cost of each process required to make the coin. Exhibit 4-15 illustrates what this process costing system might look like to make 100,000 one-ounce pure silver collector coins.

Mint managers will use this process costing information to identify opportunities to reduce process costs. For example, management may feel that the cost of fuel used in annealing is too high and either look for alternative suppliers of the fuel or possibly invest in a new more energy-efficient furnace.

In summary, the focus in process costing is to identify the cost that each process or activity used to make a product contributes to the product's total cost. This cost information is used to highlight opportunities to reduce the overall product cost

Exhibit 4-15

The National Mint: Process Costing for Silver Collector Coins

	Process						
Cost Item	Melting and Casting	Roughing and Finishing	Blanking	Rimming	Annealing	Cleaning	Coin Press
Cost transferred in from previous process	0	$2,363,000	$2,425,000	$2,467,000	$2,494,000	$2,625,000	$2,679,000
Cost added by this process							
Materials	$2,300,000	$6,000	$1,000	$3,000	$75,000	$23,000	$4,000
Direct labor	18,000	24,000	16,000	9,000	19,000	18,000	25,000
Overhead	45,000	32,000	25,000	15,000	37,000	13,000	45,000
Total cost for this process	$2,363,000	$62,000	$42,000	$27,000	$131,000	$54,000	$74,000
Cost per coin in this process	$23.63	$0.62	$0.42	$0.27	$1.31	$0.54	$0.74
Total cost per coin to date	$23.63	$24.25	$24.67	$24.94	$26.25	$26.79	$27.53
Total cost transferred to next process	$2,363,000	$2,425,000	$2,467,000	$2,494,000	$2,625,000	$2,679,000	$2,753,000

either by reengineering the process or possibly looking to an outsider to undertake one or more of the processes.

Some Process Costing Wrinkles

As you might expect process costing systems are usually more complicated than that shown in Exhibit 4-15. To illustrate one of the more important practical considerations in process costing, consider the following example.

Donald's Ducks

Donald's Ducks has just gone into business to manufacture hand-carved wooden ducks. The manufacturing process begins with a solid block of pine. Each craftsman then uses chisels, small sanders, and polishers to create the final product, which is given a light coat of clear stain.

During the most recent period, 3,500 blocks of wood were entered into production. At the end of the period 2,500 units had been completed and shipped off to customers. Exhibit 4-16 summarizes the costs incurred during the most recent period. Direct materials costs relate almost entirely to the cost of the pine blocks. Direct labor refers to the wages paid to factory employees who carve the ducks. Variable factory overhead refers to the consumables such as chisels, sanding disks, and stains the carvers use. The fixed factory overhead relates to the cost of supervisory and other factory workers and other factory-related costs such as heating, electricity, and depreciation on factory equipment.

If all production had been completed, the process costing would be trivial since the cost of each duck would be computed as $64.00 ($224,000/3,500). The issue that arises in process costing, particularly for financial reporting purposes, is how to account for partially completed work in process. To do this, we use the concept of an **equivalent unit of production**, which expresses the work equivalent, in finished units of the work, that has been invested in work in process. For example, the equivalent units of 100 units that are 40% complete are 40 (100 × 40%).

Process costing systems use two different cost terms: direct materials costs and conversion costs. **Conversion costs** include all manufacturing costs that are not direct materials costs; that is, conversion costs consist of labor and factory overhead.

In the case of Donald's Ducks, direct materials costs are $42,000 and conversion costs are $182,000 (80,000 + 8,000 + 94,000). To undertake process costing for this simple example, we begin by identifying the physical flow as shown in Exhibit 4-17.

Next we compute equivalent units. For any units that are completed, the number of equivalent units will equal the number of physical units. So our focus is on the ending work in process. Notice that since all materials are introduced at the start of production, all units in work in process will be 100% complete with regard to materials. Therefore, the equivalent units with respect to materials will equal the physical units and will be 1,000. Now suppose that, on average, the ending work in process is

Exhibit 4-16
Donald's Ducks: Production Costs

Cost Item	Amount
Direct materials	$42,000
Direct labor	80,000
Variable factory overhead	8,000
Fixed factory overhead	$94,000
Total cost this period	$224,000

Exhibit 4-17
Donald's Ducks: Physical Flows

Physical Flow	Physical Units
Opening work in process	0
Started this period	3,500
Units to account for	3,500
Completed and transferred out	2,500
Ending work in process	1,000
Units accounted for	3,500

10% complete with regard to the total work that has to be done to turn the original block of wood into the finished product. Therefore, the work done on the 1,000 blocks of wood in ending inventory is equivalent to 100 (1,000 × 10%) units of conversion work on completed units. Exhibit 4-18 summarizes our work so far.

Next we introduce the costs we need to account for. Exhibit 4-19 summarizes the costs noted in Exhibit 4-16.

The next step is to compute the cost per equivalent unit of work. To do this, we divide the total materials cost by the equivalent units of materials and the total conversion costs by the equivalent units of conversion. Exhibit 4-20 shows this calculation.

Exhibit 4-20 provides important management information since it pinpoints the cost per unit produced for each of the major production activities. The calculation shows that the materials costs per duck is $12 and the total manufacturing cost to convert the raw block of wood into the finished product is $70.

The final step is to use the equivalent cost calculation to allocate the total manufacturing costs to ending work in process and the finished goods. Exhibit 4-21 summarizes how costs would be distributed to ending work in process and finished goods. Note that, as required, all manufacturing costs have been accounted for.

Final Comments on Process Costing

In practice, process costing is more complicated when production involves multiple departments and defective (spoiled) production. However, the principles and the

Exhibit 4-18
Donald's Ducks: Equivalent Units

		Equivalent Units	
Physical Flow	Physical Units	Materials	Conversion Costs
Percentage completion			
Ending inventory		100%	10%
Opening work in process	0		
Started this period	3,500		
Units to account for	3,500		
Completed and transferred out	2,500	2,500	2,500
Ending work in process	1,000	1,000	100
Units accounted for	3,500		
Total work done this period		3,500	2,600

Exhibit 4-19
Donald's Ducks: Equivalent Units and Production Costs

		Equivalent Units	
Physical Flow	Physical Units	Materials	Conversion Costs
Percentage completion			
Ending inventory		100%	10%
Opening work in process	0		
Started this period	3,500		
Units to account for	3,500		
Completed and transferred out	2,500	2,500	2,500
Ending work in process	1,000	1,000	100
Units accounted for	3,500		
Work done this period		3,500	2,600
	Total Production Costs	Materials	Conversion Costs
Costs in opening inventory	$0	$0	$0
Costs incurred this period	224,000	42,000	182,000
Costs incurred to date	$224,000	$42,000	$182,000

Exhibit 4-20
Donald's Ducks: Costs per Equivalent Unit

		Equivalent Units	
Physical Flow	Physical Units	Materials	Conversion Costs
Percentage Completion			
Ending Inventory		100%	10%
Opening work in process	0		
Started this period	3,500		
Units to account for	3,500		
Completed and transferred out	2,500	2,500	2,500
Ending work in process	1,000	1,000	100
Units accounted for	3,500		
Work done this period		3,500	2,600
	Total Production Costs	Materials	Conversion Costs
Costs in opening inventory	$0	0	0
Costs incurred this period	224,000	42,000	182,000
Costs incurred to date	$224,000	$42,000	$182,000
Divide by equivalent units of work this period		3,500	2,600
Cost per equivalent unit	$82.00	$12.00	$70.00
Total costs to account for	$224,000		

objectives remain the same: compute the cost per equivalent unit for each of the components of manufacturing in order to identify where process improvements (i.e., cost reductions) might be possible. Dealing with these more complex issues is left to a more advanced course in management accounting.

Exhibit 4-21
Donald's Ducks: Costs Distributed to Ending Work in Process and Finished

Physical Flow	Physical Units	Equivalent Units: Materials	Equivalent Units: Conversion Costs
Percentage completion			
Ending inventory		100%	10%
Opening work in process	0		
Started this period	3,500		
Units accounted for	3,500		
Completed and transferred out	2,500	2,500	2,500
Ending work in process	1,000	1,000	100
Units accounted for	3,500		
Work done this period		3,500	2,600

	Total Production Costs	Materials	Conversion Costs
Costs in opening inventory	$0	0	0
Costs incurred this period	224,000	42,000	182,000
Costs incurred to date	$224,000	$42,000	$182,000
Divide by equivalent units of work this period		3,500	2,600
Cost per equivalent unit	$82.00	$12.00	$70.00
Total costs to account for	$224,000		
Cost Allocation			
Work in process ending inventory			
Materials	12,000	= 1,000 equivalent units × $12 per unit	
Conversion costs	7,000	= 100 equivalent units × $70 per unit	
Total work in process	$19,000		
Completed and transferred out			
Materials	30,000	= 2,500 equivalent units × $12 per unit	
Conversion costs	175,000	= 2,500 equivalent units × $70 per unit	
Total cost transferred out	$205,000		
Total costs accounted for	$224,000		

Epilogue to Strict's Custom Framing

Here is what Enid did to estimate the other costs involved in framing the portraits: First she identified the three departments used to complete the framing. The first department, Manufacturing Division, cut the frame pieces from the stock provided by the supplier and assembled the frames. Enid estimated that the total of all overhead costs in the Manufacturing Division, including labor, machinery, and other supplies was about $675,000. Since work in this department was labor intensive and labor driven, Enid decided that costs in this department were driven by labor hours. Enid estimated that the labor capacity in the Manufacturing Division was 15,000 hours so she estimated the conversion cost per labor hour as $45 per hour ($675,000/15,000). From observing workers prepare the prototype frame, Enid believed that a reasonable estimate of the time required to produce a frame in this department was 0.20 hour.

Exhibit 4-22
Strict's Custom Framing: Cost Summary

Direct Cost		
Materials	$350.00	
Shipping	100.00	$450.00
Conversion Cost		
Manufacturing Division (0.20 hours @ $45.00)	$9.00	
Finishing Division (0.30 hours @ $25.00)	7.50	
Packaging Division (((0.25 + (0.3 × 2) + 0.50)/60) hours @ $30)	0.68	17.18
Total Manufacturing Cost		$467.18

The second department in the framing operation is the Finishing Division. In this division workers complete the framing by adding the portrait, mat, glass, backing, and hardware. Enid estimated that the total of all overhead costs in the Finishing Division, including labor, machinery, heat, and other supplies, is about $625,000. Since work in this division is labor intensive and labor driven, Enid decided that costs in this department are driven by labor hours. Enid estimated that the labor capacity in the Finishing Division is 25,000 hours so she estimated the conversion cost per labor hour as $25 per hour ($625,000/25,000). From observing workers prepare the prototype frame, Enid believed that a reasonable estimate of the time required to finish the frames in this department is 0.30 hour.

The third department in the framing operation is the Packaging Division. In this division the frame is placed on the bed of a small machine that wraps the finished portrait first in bubble wrap, cardboard, and then paper before applying a sealing tape. Enid estimated the total overhead costs in this division, which consists of labor and machine overhead, to be $150,000. Since work in the Packaging Division is machine driven, Enid decided that costs in this department are driven by machine hours. Enid estimated the capacity in the Packaging Division to be 5,000 machine hours and the estimated conversion cost per machine hour to be $30 per hour ($150,000/5,000). The time to package a finished product is about 0.25 minute (while the employee placed the product on the packaging machine bed), 0.30 minute per square foot of portrait wrapped, and 0.50 minute to remove the wrapped portrait from the packaging machine and place it in the shipping bin. The size of these portraits is approximately 2 square feet.

With this information Enid developed the cost summary shown in Exhibit 4-22.

Summary

This chapter reviewed the basic elements of costing systems. Costing systems focus on computing the cost of a cost object. Common cost objects are products, customers, product lines, departments, or even entire organizational divisions. A cost that is uniquely and unambiguously attributable to a cost object is called a direct cost. Most, but not all, direct costs are the costs of consumables such as raw materials that are used to produce a product. The identifying characteristic of a direct cost is that it depends on how much of a resource is used.

Indirect costs are related to the costs of capacity resources such as machinery and factory supervision. The identifying characteristic of an indirect cost is that it depends on how much of the resource was acquired and not how much is used.

Cost analysts assign direct costs and allocate indirect costs to cost objects. Indirect costs are usually allocated using a predetermined indirect cost rate (also called a predetermined overhead rate or cost driver rate), which is computed by dividing the expected cost of the capacity resource by its practical capacity. The costs of indirect resources are accumulated in cost pools that are often organized around departments or activities.

Most organizations have so-called service departments that do not directly produce goods or services for customers, but instead provide services to the departments or activities that produce goods or services. Service department costs have traditionally been allocated to the production departments, where they are accumulated with the production departments' own costs and allocated to the cost objects. The appendix to this chapter explains allocation of service department costs to production departments.

Appendix 4-1

Allocating Service Department Costs

For convenience, in this appendix we will call departments that directly produce goods or services production departments. Factory production departments include machining, assembly, and finishing. Most organizations also have so-called service departments that do not directly produce goods or services for customers, but instead provide services to the departments or activities that produce goods or services. For example, factory service departments include machine maintenance and production scheduling. In a hospital, hospital maintenance and the personnel department are examples of service departments.

Service department costs have traditionally been allocated to the production departments, where they are accumulated with the production departments' own costs and allocated to the cost objects. This appendix explains three methods of allocating service department costs to production departments.

The process of allocating service department costs is best illustrated by an example. Accounting for the costs of service departments begins with accumulating each service department's costs. Recall in what follows that the objective is then to allocate all service department costs to the production departments.

Wellington Regional Hospital

Wellington Regional Hospital (WRH), which is a rural hospital, has four departments: Medical, Surgical, Maintenance, and Administration. (WRH has contracted out housekeeping and cafeteria services.) The Medical and Surgical Departments are production departments, and the Maintenance and Administration Departments are service departments.

For the upcoming accounting period the expected costs in the Maintenance and Administration Departments are $10,000,000 and $25,000,000 respectively.

Ramona Nasser, the WRH controller, has decided that the cost driver for the Maintenance and Administration Departments should be weighted square meters of floor space occupied and number of employees, respectively. Ramona is proposing a weighted cost driver because although the Surgical Department occupies only one-sixth of the floor space occupied by the Medical Department, the maintenance services provided to the Surgical Department are four times more intense than for the Medical Department.

Since the Medical and Surgical Departments must develop their predetermined overhead rates for the upcoming period, Ramona plans to allocate the planned service department costs using the planned service levels.

Exhibit 4-23 presents the planned results for the upcoming period showing the planned service units provided and the planned costs for each of the service departments.

Ramona also advises that the practical capacity of the Maintenance Department is 60,000 square meters of floor space, and the practical capacity of the Administration Department is 750 employees. Therefore, the planned idle capacity of the two departments is 10% [(60,000 − 54,000)/60,000] and 20% [(700 − 560)/700], respectively. Therefore, Ramona will charge $1,000,000 (10%) of the costs of the Maintenance Department and $5,000,000 (20%) of the costs of the Administration Department to the Cost of Idle Capacity account leaving balances shown in Exhibit 4-24 to be allocated.

Exhibit 4-23
Wellington Regional Hospital Planned Service Units and Costs

	Maintenance	Administration	Medical	Surgical	Total	Total Cost
Maintenance	1,500	2,500	30,000	20,000	54,000	$10,000,000
Administration	110	50	250	150	560	$25,000,000
						$35,000,000

Exhibit 4-24
Wellington Regional Hospital: Adjustment for Idle Capacity

	Maintenance	Administration	Medical	Surgical	Total	Total Cost
Maintenance	1,500	2,500	30,000	20,000	54,000	$9,000,000
Administration	110	50	250	150	560	$20,000,000
						$29,000,000

Approaches to Allocating Service Department Costs

Direct Method

The **direct method** of allocating service department costs ignores the services provided to the service departments. Dropping the services provided to maintenance and administration results in the following distribution of services, costs, and cost per unit of service.

Because the Maintenance Department provides a total of 50,000 units of service to the Medical and Surgical Departments and the total cost to be allocated is $9,000,000, the cost per unit of service provided is $180 (9,000,000/50,000). Therefore, the Maintenance Department costs to be allocated to the Medical and Surgical Departments are $5,400,000 (30,000 × $180) and $3,600,000 (20,000 × $180), respectively.

Using the same approach the cost per unit of service provided by the Administration Department is $50,000 (20,000,000/400) and the Maintenance Department costs allocated to the Medical Departments are $15,000,000 (300 × $50,000) and $5,000,000 (100 × $50,000), respectively. Exhibit 4-25 summarizes the results. Therefore, the total of all service department costs allocated to the Medical and Surgical Departments are $20,400,000 and $8,600,000 as shown in this exhibit.

Although the direct method is simple, the complaint is that by ignoring the services provided among service departments the direct method introduces the potential for cost distortion.

Sequential Method

The **sequential method** (also called the *step* or *step-down method*) of allocating service department costs partially deals with the complaint that the direct method ignores services provided among service departments by using the following approach.

In the sequential method one of the service departments is chosen to allocate its costs first. That service department ignores services that it provides to itself and allocates its costs to the remaining departments in proportion to the services provided to each department.

Once a service department's costs have been allocated, it is dropped from consideration and the process moves (steps) to the next department. This process continues until all the service departments have allocated their costs. Exhibit 4-26 illustrates the result of using the sequential method with the Maintenance Department allocating its costs first.

Start by computing the service rate ($171.43) for the Maintenance Department by dividing the total cost to be allocated ($9,000,000) by the total service units provided to the remaining departments (52,500). This rate is then used to allocate the Maintenance Department's costs to the remaining departments. For example, the Medical Department is allocated $5,142,857.14 (30,000 × $171.43). (If you are following along these calculations note that the numbers in the exhibit are computed using computer-level accuracy rather than the rounded rate shown in the Exhibit 4-26.)

Exhibit 4-25
Direct Method

		Support Units Provided to					
		Maintenance	Administration	Medical	Surgical	Total	Rate
	Direct costs	$9,000,000.00	$20,000,000.00			$29,000,000.00	
Support Units Provided From	Maintenance						
	Cost to allocate	$9,000,000.00					
	Support units provided			30,000	20,000	50,000	$180.00
	Allocation	($9,000,000.00)		$5,400,000.00	$3,600,000.00		
	Closing balance	$0.00					
	Administration						
	Cost to allocate		$20,000,000.00				
	Support units provided			300	100	400	$50,000.00
	Allocation		($20,000,000.00)	$15,000,000.00	$5,000,000.00		
	Closing balance		$0.00	$20,400,000.00	$8,600,000.00	$29,000,000.00	

As you can see, the Maintenance Department allocates $428,571.43 of its costs to the Administration Department. This cost is added to the Administration Department's direct costs of $20,000,000 resulting in a total of $20,428,571.43 of Administration Department costs to be allocated. Note that the Maintenance Department is now dropped from the process. Following the same steps used by the Maintenance Department, you should be able to compute the Administration Department's cost allocations in the above exhibit. At this point the service department cost allocation process is complete.

Exhibit 4-26
Sequential Method: Maintenance Department Allocated First

		Support Units Provided to					
		Maintenance	Administration	Medical	Surgical	Total	Rate
		$9,000,000.00	$20,000,000.00			$29,000,000.00	
Support Units Provided From	Maintenance						
	Cost to allocate	$9,000,000.00					
	Units provided		2,500	30,000	20,000	52,500	$171.43
	Allocation	($9,000,000.00)	$428,571.43	$5,142,857.14	$3,428,571.43		
	New total	$0.00					
	Administration						
	Cost to allocate		$20,428,571.43				
	Units provided			250	150	400	$51,071.43
	Allocation		($20,428,571.43)	$12,767,857.14	$7,660,714.29		
	New total		$0.00				
	Total			$17,910,714.29	$11,089,285.71	$29,000,000.00	

Cost analysts have two complaints about the sequential method. The first complaint is that, although it considers some of the support services provided among service departments, it does not consider all of them. The second complaint is that the order in which the service departments' costs are allocated makes a difference. Exhibit 4-27 illustrates the sequential method with the Administration Department allocating its costs first. You can use Exhibit 4-27, first, to test your understanding of the sequential method and, second, to see, by comparing these results with the results in Exhibit 4-26 of allocating the Maintenance Department first, that order does make a difference.

The Reciprocal Method

The **reciprocal method** answers the complaints leveled against the direct and sequential methods by considering all support services.

The reciprocal method has two steps. The first step computes the reciprocal cost of each service department. The second step uses each service department's reciprocal cost to allocate its costs.

In step 1 the cost analyst begins by developing a reciprocal cost equation for each service department. The reciprocal cost for each department is the sum of its direct cost and its share (based on share of total use) of the reciprocal costs of all the service departments (including itself). Here, using the abbreviation RC for reciprocal cost, are the reciprocal cost equations for each of the service departments:

$$\begin{aligned} RC_{Maintenance} &= \$9{,}000{,}000 \\ &\quad + (1{,}500/54{,}000)\ RC_{Maintenance} \\ &\quad + (110/560)\ RC_{Administration} \\ RC_{Administration} &= \$20{,}000{,}000 \\ &\quad + (2{,}500/54{,}000)\ RC_{Maintenance} \\ &\quad + (50/560)\ RC_{Administration} \end{aligned}$$

With two equations in two unknowns (the reciprocal costs), the analyst can use algebra, or a computer, to solve the equations to find

$$\begin{aligned} RC_{Maintenance} &= \$13{,}836{,}226.42 \\ RC_{Administration} &= \$22{,}664{,}150.94 \end{aligned}$$

This completes step 1.

In step 2 these reciprocal costs are used to allocate the service department costs to the production departments. These costs are allocated in proportion to each production department's use of the service department. Here are the resulting service department allocation equations:

$$\begin{aligned} &\text{Total service department cost allocation} \\ &\quad \text{to the Medical Department} \\ &= (30{,}000/54{,}000)\ RC_{Maintenance} \\ &\quad + (250/560)\ RC_{Administration} \\ &= \$17{,}804{,}716.98 \end{aligned}$$

Exhibit 4-27
Sequential Method with the Administration Department Costs Allocated First

Support Units Provided From	Support Units Provided to: Administration	Maintenance	Medical	Surgical	Total	Rate
	$20,000,000.00	$9,000,000.00			$29,000,000.00	
Administration						
Cost to allocate	$20,000,000.00					
Units provided		50	250	150	450	$44,444.44
Allocation	($20,000,000.00)	$2,222,222.22	$11,111,111.11	$6,666,666.67		
New total	$0.00					
Maintenance						
Cost to allocate		$11,222,222.22				
Units provided			30,000	20,000	50,000	$224.44
Allocation		($11,222,222.22)	$6,733,333.33	$4,488,888.89		
New total		$0.00				
Total			$17,844,444.44	$11,155,555.56	$29,000,000.00	

Exhibit 4-28
Summary of Cost Allocations: Four Methods

Support Department Cost Allocation Method	Allocation to: Medical Department	Allocation to: Surgical Department	Total
Direct method	$20,400,000.00	$8,600,000.00	$29,000,000.00
Sequential method 1	$17,910,714.29	$11,089,285.71	$29,000,000.00
Sequential method 2	$17,844,444.44	$11,155,555.56	$29,000,000.00
Reciprocal method	$17,804,716.98	$11,195,283.02	$29,000,000.00

Total service department cost allocation to the Surgical Department
$= (20{,}000/54{,}000)\ RC_{Maintenance} + (150/560)\ RC_{Administration}$
$= \$11{,}195{,}283.02$

In practice, the reciprocal method can be implemented using Microsoft's Excel or Open Office's Calc since these spreadsheets are easily programmed to solve systems of equations.

Summary

Exhibit 4-28 provides a summary of the cost allocations provided by the four alternatives.

As you can see either of the sequential methods provides a service department cost allocation that is quite close to the reciprocal method cost allocation. Regrettably, there is no reliable way to predict when any of the alternative methods will provide a good approximation of the cost allocation provided by the reciprocal method. However, as mentioned earlier, the reciprocal method is easily implemented using a computer spreadsheet; therefore, computational convenience is not an issue in choosing a service department cost allocation method. (In fact, programming a computer spreadsheet to undertake the sequential method allocations is the most complicated of the three methods.)

Key Terms

applied indirect costs, 129
capacity-related resource, 125
consumable resource, 125
conversion costs, 141
cost driver rate, 129
cost object, 125
cost pool, 128
death spiral, 137
direct cost, 125
direct method (for service department allocations), 161
equivalent unit of production, 141
finished goods inventory, 123
fixed manufacturing overhead, 128
flexible resource, 125
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job order costing, 138
practical capacity, 129
predetermined overhead rate, 129
process costing, 139
reciprocal method (for service department allocations), 162
sequential method (for service department allocations), 161
variable overhead, 128
work-in-process inventory, 136

Assignment Materials

Questions

4-1 Describe the flow of costs from raw materials to cost of goods sold in a manufacturing organization. (LO 1)

4-2 How do the cost flows in a retail organization or service organization differ from those in a manufacturing organization? (LO 1)

4-3 Provide several examples of cost objects. (LO 2)

4-4 Compare the defining characteristic and cost behavior of a consumable (flexible) resource to those of a capacity-related resource. (LO 2)

4-5 Define direct cost and indirect cost and provide an example of each. (LO 2)

4-6 What has increased the need for cost systems that accurately deal with indirect manufacturing costs? **(LO 2)**

4-7 In the context of computing a predetermined indirect cost rate, what is a cost driver? **(LO 3)**

4-8 What are predetermined indirect cost rates commonly called in practice? **(LO 3)**

4-9 Why are costs estimated for individual jobs? **(LO 5, 6)**

4-10 How are indirect cost rates determined? **(LO 3)**

4-11 How is overhead cost estimated for individual jobs? **(LO 3)**

4-12 What are indirect cost pools? **(LO 3)**

4-13 Why do firms use multiple indirect cost pools? **(LO 3, 4, 5)**

4-14 What problem arises when cost driver rates are based on planned or actual short-term usage? **(LO 4)**

4-15 Why are predetermined cost driver rates used when recording job costs? **(LO 3)**

4-16 "Use of a single cost driver rate when an indirect cost pool includes costs that have different cost drivers (causes of costs) leads to distortions in job costs." Do you agree with this statement? Explain. **(LO 4)**

4-17 What are the three options for dealing with the difference between actual and applied capacity (overhead) costs? **(LO 3, 6)**

4-18 How might computing the cost driver rate by using the planned level of the cost driver lead to a death spiral? **(LO 3, 4, 6)**

4-19 How is practical capacity computed for machines and labor? **(LO 3, 6)**

4-20 What does the term *conversion costs* mean? **(LO 5, 6)**

4-21 What is the basic procedure for determining product costs in continuous processing plants? **(LO 6)**

4-22 What are the similarities and differences between job order costing and multistage process costing systems? **(LO 5, 6)**

4-23 (Appendix) What is the difference between production departments and service departments? **(LO 7)**

Exercises

LO 3, 4, 6

4-24 ***Indirect cost rates and the death spiral*** Famous Flange Company manufactures a variety of special flanges for numerous customers. Annual capacity-related (manufacturing overhead) costs are $4,000,000 and the practical capacity level of machine hours is 120,000. The company uses planned machine hours as the cost driver in determining the plantwide cost driver rate. Until last year, the company used approximately 100,000 machine hours per year. Last year, competition increased and demand for the company's flanges fell. In the face of continuing competition, the company estimates that it will use 80,000 machine hours in the coming year. The company sets its prices at 150% of production cost per unit.

Required

(a) What is likely to happen if demand decreases further and Famous Flange continues to recompute its cost driver rate using the same approach?

(b) Advise the company on choosing a cost driver quantity for computing cost driver rates and explain why you advocate your choice of quantity.

LO 3, 4

4-25 ***Practical capacity and machine hours*** Calla Manufacturing Company has 40 machines in its factory. The machines run for two shifts each day, with 30 workers per shift. Allowing for machine maintenance and break time for machine operators, each machine can be used for production for an average of 6.5 hours per shift. Assuming the factory operates for an average of 22 days per month, what is Calla's practical capacity number of machine hours per month?

LO 3, 6

4-26 ***Practical capacity and labor hours*** Kappa Company runs two shifts each day. Workers on average have four weeks off per year and after training and

breaks, average 34 hours per week. What is Kappa's practical capacity number of labor hours per year?

LO 6 **4-27** ***Job cost*** Ernie's Electronics, Inc., delivered 1,000 custom-designed computer monitors to its customer, Video Shack. The following cost information was compiled in connection with this order:

Direct Materials Used

Part A327: 1 unit costing $60 per monitor
Part B149: 1 unit costing $120 per monitor

Direct Labor Used

Assembly: 6 hours per monitor at the rate of $10 per hour
Inspection: 1 hour per monitor at the rate of $12 per hour

In addition, the company applies manufacturing overhead costs to jobs at the rate of $5 per direct labor hour. The selling price for each monitor is $350.

Required

(a) Determine the total cost for this job.
(b) Determine the gross margin per monitor.

LO 6 **4-28** ***Job cost*** The following costs pertain to job 923 at Becker Auto Shop.

	Quantity	Price
Direct materials:		
Engine oil	11 ounces	$2 per ounce
Lubricant	2 ounces	3 per ounce
Direct labor	3 hours	15 per hour
Overhead costs (based on direct labor hours)		10 per hour

Determine the total cost for job 923.

LO 3, 6 **4-29** ***Job order costing and consulting*** Mackenzie Consulting computes the cost of each consulting engagement by adding a portion of firmwide overhead costs to the labor cost of the consultants on the engagement. The overhead costs are assigned to each consulting engagement using a cost driver rate based on consultant labor costs. Mackenzie Consulting's overhead costs are $5 million per year, and total consultant labor cost is estimated at $2.5 million per year.

Required

(a) What is Mackenzie Consulting's cost driver rate?
(b) If the consultant labor cost on an engagement is $25,000, what cost will Mackenzie Consulting compute as the total cost of the consulting engagement?

LO 3, 6 **4-30** ***Job order costing and cost driver rates*** The Brinker Company uses a job order costing system at its local plant. The plant has a machining department and a finishing department. The company uses machine hours to allocate machining department overhead costs to jobs and uses direct labor cost to allocate finishing department overhead costs to jobs. Cost and practical capacity estimates for the current year are as follows:

	Machining Department	Finishing Department
Manufacturing overhead costs	$350,000	$280,000
Machine hours	14,000	1,400
Direct labor hours	3,500	15,400
Direct labor cost	$105,000	$350,000

Required

(a) Determine the cost driver rate for each department.
(b) Cost records for job 101 show the following:

	Machining Department	Finishing Department
Direct materials cost	$8,000	$1,400
Direct labor cost	$250	$800
Direct labor hours	7	35
Machine hours	50	6

Determine the total cost charged to job 101.

LO 3, 4, 6 **4-31** ***Single rate versus departmental rates*** Eastern Wood Products has two production departments: cutting and assembly. The company has been using a plantwide cost driver rate computed by dividing plantwide overhead costs by total plantwide direct labor hours. The estimates for overhead costs and practical capacity quantities of cost drivers for the current year follow:

	Cutting	Assembly	Total
Manufacturing overhead	$25,000	$35,000	$60,000
Direct labor hours	1,000	3,000	4,000
Machine hours	4,000	2,000	6,000

Required

(a) Compute the plantwide cost driver rate.
(b) Determine departmental cost driver rates based on direct labor hours for assembly and machine hours for cutting.
(c) Provide reasons why Eastern Wood might use the method in part a or the one in part b.

LO 3, 4, 6 **4-32** ***Fluctuating cost driver rates and effect on markup pricing*** Morrison Company carefully records its costs because it bases prices on the cost of the goods it manufactures. Morrison also carefully records its machine usage and other operational information. Manufacturing costs are computed monthly, and prices for the next month are determined by adding a 20% markup to each product's manufacturing costs. The cost driver rate is based on machine hours as follows:

Month	Actual Machine Hours	Month	Actual Machine Hours
January	1,350	July	1,400
February	1,400	August	1,400
March	1,500	September	1,500
April	1,450	October	1,600
May	1,450	November	1,600
June	1,400	December	1,600

Profits have been acceptable until the past year, when Morrison began to face increased competition. The marketing manager reported that Morrison's sales force finds the company's pricing puzzling. When demand is high, the company's prices are low, and when demand is low, the company's prices are high. Practical capacity is 1,500 machine hours per month. Practical capacity is exceeded in some months by operating the machines overtime beyond regular shift hours. Monthly machine-related overhead costs, all fixed, are $70,000 per month.

Required

(a) Compute the monthly overhead cost driver rates that Morrison used last year.
(b) Suggest a better approach to developing cost driver rates for Morrison and explain why your method is better.

LO 5, 6 **4-33** ***Process costs*** Fancy Foods Company produces and sells canned vegetable juice. The ingredients are first combined in the blending department and then packed in gallon cans in the canning department. The following information pertains to the blending department for January:

Item	Price per Gallon	Gallons
Ingredient A	$0.40	10,000
Ingredient B	0.60	20,000
Vegetable juice		27,000
Materials loss		3,000

Conversion costs for the blending department are $0.55 per gallon for January. Determine the cost per gallon of blended vegetable juice before canning.

LO 5, 6 **4-34** ***Process costs*** Pitman Chemical Company manufactures and sells Goody, a product that sells for $10 per pound. The manufacturing process also yields 1 pound of a waste product, called Baddy, in the production of every 10 pounds of Goody. Disposal of the waste product costs $1 per pound. During March, the company manufactured 200,000 pounds of Goody. Total manufacturing costs were as follows:

Direct materials	$232,000
Direct labor	120,000
Manufacturing overhead costs	60,000
Total costs	$412,000

Determine the cost per pound of Goody.

LO 5, 6 **4-35** ***Process costing equivalent units*** The information below pertains to July production at Porter Company's paint factory, which produces paints for household interiors:

	Gallons	Materials	Conversion
Work in process, July 1	3,000	30% complete	20% complete
Started in July	7,000		
To account for	10,000		
Completed and transferred out	6,000	100% complete	100% complete
Work in process, July 31	4,000	25% complete	10% complete
Accounted for	10,000		

Using the weighted-average method, determine the number of equivalent units of production for materials and conversion during July.

LO 7 (Appendix) **4-36** ***Service department cost allocation, direct method*** San Rafael Company has two production departments, assembly and finishing, and two service departments, machine setup and inspection. Machine setup costs are allocated on the basis of number of setups, whereas inspection costs are allocated on the basis of number of direct labor hours. Selected information on the four departments follows:

Item	Direct Costs	Number of Setups	Direct Labor Hours
Machine setup	$40,000	0	0
Inspection	15,000	0	0
Assembly	25,000	300	200
Finishing	20,000	100	500

Required

(a) Using the direct method, determine the amount of machine setup costs allocated to the two production departments.
(b) Using the direct method, determine the amount of inspection costs allocated to the two production departments.

LO 7 (Appendix) **4-37** ***Sequential allocation*** Carleton Company has two service departments and two production departments. Information on annual manufacturing overhead costs and cost drivers follows:

	Service Departments		Production Departments	
Item	S1	S2	P1	P2
Overhead costs	$65,000	$55,000	$160,000	$240,000
Direct labor hours	2,000	1,500	2,000	3,000
Number of square feet	800	1,200	2,400	2,600

The company allocates service department costs using the sequential method. First, S1 costs are allocated on the basis of direct labor hours. Next, S2 costs are allocated on the basis of square footage. The square footage for S1 is assumed to be zero for this purpose. Determine the total overhead costs allocated to each of the two production departments.

LO 7 (Appendix) **4-38** ***Direct, sequential, and reciprocal allocation*** Ming Company has two service departments (S1 and S2) and two production departments (P1 and P2). Last year, directly identified overhead costs were $300,000 for S1 and $300,000 for S2. Information on the consumption of their services follows:

	User Departments			
Supplying Departments	S1	S2	P1	P2
S1	0%	40%	30%	30%
S2	25%	0%	25%	50%

Required

(a) Determine the service department costs allocated to the two production departments using the direct method.
(b) Determine the service department costs allocated to the two production departments using the sequential method beginning with the allocation of S1 department costs.

(c) Determine the service department costs allocated to the two production departments using the reciprocal method.

Problems

LO 3, 6 **4-39** ***Reconciling actual and applied capacity costs*** Hoyt Company uses a plantwide cost driver rate with machine hours as the cost driver. At the beginning of last year, Hoyt Company estimated its capacity-related (overhead) costs as $15,000,000 for a practical capacity of 100,000 machine hours per year. During the year, actual overhead costs were $14,200,000 and production required 90,000 machine hours.

Required

(a) Determine Hoyt Company's plantwide cost driver rate and calculate the overhead cost applied to production last year.
(b) Suppose the company charges the difference between actual and applied overhead costs to cost of goods sold at the end of the year. Calculate the difference and state whether the result will be an increase or decrease in the previously recorded cost of goods sold.
(c) Suppose now that the company prorates the difference between actual and applied overhead costs to work in process, finished goods, and cost of goods sold. If the proportions of applied indirect cost in the ending balances of these accounts this period are 20% in ending work in process, 45% in finished goods inventory, and 35% in cost of goods sold, by how much will the three accounts be increased or decreased from their previously recorded amounts?
(d) Now suppose that the company wishes to decompose the difference between actual and applied overhead costs to gain further insight into the difference. Compute the difference between actual and estimated overhead cost and the difference between estimated overhead cost and applied overhead cost.
(e) What insight does management gain from the approach in part d as compared to the approaches in parts b and c?

LO 3, 5, 6 **4-40** ***Job costing for services*** The Hillman Company sells and services lawn mowers, snow blowers, and other equipment. The service department uses a job order cost system to determine the cost of each job, such as oil changes, tune-ups, and repairs. The department assigns conversion costs through a cost driver rate on the basis of direct labor hours. The cost driver rate additionally includes a markup of 25% on the job's conversion costs in order to provide a reasonable profit for Hillman. The customer's invoice itemizes prices for parts and labor, where the stated labor rate is the department's cost driver rate, which includes direct labor costs, assigned overhead costs, and the 25% markup on conversion costs. Hillman Company's service department estimated the following information for the current year:

Salaries of mechanics	$120,000
Fringe benefits	54,000
General and administrative	18,000
Depreciation	42,000
Billable direct labor hours	4,500

Required

(a) Determine Hillman Company's service department's cost driver rate for assigning conversion costs on the basis of billable direct labor hours.
(b) Job 254 required $47.40 of materials and 0.7 direct labor hour. Determine the price charged for job 254.

LO 1, 6 **4-41** ***Job costing and departmental cost driver rates*** The Leblanc Company employs a job order costing system to account for its costs. The company has three production departments. Separate departmental cost driver rates are employed because the demand for overhead resources for the three departments is very different. All jobs generally pass through all three production departments. Data regarding the hourly direct labor rates, cost driver rates, and three jobs for which work was done during June appear below. Jobs 101 and 102 were completed during June, while job 103 was not completed as of June 30. The costs charged to jobs not completed at the end of a month are shown as work in process inventory at the end of that month and at the beginning of the next month:

Production Departments	Direct Labor Rates	Cost Driver Rates	
Department 1	$12	150% of direct material cost	
Department 2	18	$8 per machine hour	
Department 3	15	200% of direct labor cost	
	Job 101	Job 102	Job 103
Beginning work in process	$25,500	$32,400	$0
Direct materials:			
Department 1	$40,000	$26,000	$58,000
Department 2	3,000	5,000	14,000
Department 3	0	0	0
Direct labor hours:			
Department 1	500	400	300
Department 2	200	250	350
Department 3	1,500	1,800	2,500
Machine hours:			
Department 1	0	0	0
Department 2	1,200	1,500	2,700
Department 3	150	300	200

Required

(a) Determine the total cost of completed job 101.
(b) Determine the total cost of completed job 102.
(c) Determine the ending balance of work-in-process inventory for job 103 as of June 30.

LO 1, 3, 4 **4-42** ***Allocating scheduling service costs*** Airport Coach Service Company operates scheduled coach service from Boston's Logan Airport to downtown Boston and to Cambridge. A common scheduling service center at the airport is responsible for ticketing and customer service for both routes. The service center is regularly staffed to service traffic of 2,400 passengers per week: two-thirds for downtown Boston passengers and the balance for Cambridge passengers. The cost to operate this service center is $7,200 per week normally, but it is higher during weeks when additional help is required to

service higher traffic levels. The service center costs and number of passengers serviced during the weeks of August follow:

Week	Cost	Boston Passengers	Cambridge Passengers
1	$7,200	1,600	800
2	7,200	1,500	900
3	7,600	1,650	800
4	7,800	1,700	850
5	7,200	1,700	700

Required

(a) How much of the service center costs will be allocated to the Boston service and to the Cambridge service if the costs are allocated in proportion to the number of actual passengers?
(b) Suggest an improved approach to allocating the costs and explain why your method is an improvement. Using your approach, how much of the service center costs will be charged to the Boston service and to the Cambridge service?

LO 3, 4, 6 **4-43** ***Job cost, markup, and single rate versus departmental rates*** Modern Metalworks Company has two departments, milling and assembly. The company uses a job costing system with a plantwide cost driver rate that is computed by dividing plantwide overhead costs by total plantwide practical capacity direct labor hours. The following cost and practical capacity estimates are for October:

	Milling	Assembly
Overhead costs	$120,000	$160,000
Direct labor hours	8,000	12,000
Machine hours	12,000	6,000

The following information pertains to job 714, which was started and completed during October:

	Milling	Assembly
Direct labor hours	10	40
Machine hours	18	8
Direct materials costs	$800	$50
Direct labor costs	$100	$600

Required

(a) Determine the cost of job 714.
(b) Suppose that instead of using the plantwide cost driver rate, the company uses machine hours as the cost driver for applying overhead costs in the milling department, and uses direct labor hours as the cost driver in the assembly department. Compute these departmental cost driver rates and determine the cost of job 714 using these rates.
(c) Using the costs you computed in parts a and b, determine the bid price that Modern Metalworks will quote under each cost system if it uses a 25% markup on total manufacturing cost.
(d) Provide reasons why Modern Metalworks might prefer the method in part a or the one in part b.

LO 3, 4, 6 **4-44** ***Single rate versus departmental rates*** Bravo Steel Company supplies structural steel products to the construction industry. Its plant has three production departments: cutting, grinding, and drilling. The estimated overhead cost and practical capacity direct labor hours and machine hours for each department for the current year follow:

	Cutting	Grinding	Drilling
Overhead cost	$504,000	$2,304,000	$2,736,000
Estimated direct labor hours	60,000	96,000	144,000
Estimated machine hours	960,000	480,000	360,000

Job ST101 consumed the following direct labor and machine hours:

	Cutting	Grinding	Drilling
Direct labor hours	2,000	2,500	3,000
Machine hours	20,000	3,000	2,000

Required

(a) Suppose that a plantwide cost driver rate is computed by dividing plantwide overhead costs by plantwide practical capacity direct labor hours. Determine the overhead cost applied to job ST101.
(b) Determine the departmental cost driver rates and overhead costs applied to job ST101 if machine hours are used as the cost driver in the cutting department and direct labor hours are used as the cost driver for the grinding and drilling departments.
(c) Explain why Bravo Steel might prefer a plantwide rate or departmental cost driver rates.

LO 3, 4, 6

4-45 ***Job costing*** The Gonzalez Company uses a job order costing system at its plant in Green Bay, Wisconsin. The plant has a machining department and a finishing department. The company uses two cost driver rates for allocating manufacturing overhead costs to job orders: one on the basis of machine hours for allocating machining department overhead costs and the other on the basis of direct labor cost for allocating the finishing department overhead costs. Estimates for the current year follow:

	Machining Department	Finishing Department
Manufacturing overhead cost	$500,000	$400,000
Machine hours	20,000	2,000
Direct labor hours	5,000	22,000
Direct labor cost	$150,000	$500,000

Required

(a) Determine the two departmental cost driver rates.
(b) Last month, cost records for job 511 show the following:

	Machining Department	Finishing Department
Direct materials cost	$12,000	$2,000
Direct labor cost	$300	$1,200
Direct labor hours	10	50
Machine hours	80	8

Determine the total costs charged to job 511.
(c) Explain why Gonzalez Company uses two different cost driver rates in its job costing system.

LO 5, 6

4-46 ***Process costing*** Connor Chemical Company's plant processes batches of organic chemical products through three stages after starting with raw materials: (1) mixing and blending, (2) reaction chamber, and (3) pulverizing and packing. Connor Chemical's estimates for the total conversion costs for

each of the three processing stages are shown in the following table. These costs include production labor assigned to each stage, support labor performing tasks (such as handling the output of the previous stage and setting up for the new stage), and laboratory testing. Additional materials for packing are needed in the pulverizing and packing stage:

	Mixing and Blending	Reaction Chambers	Pulverizing and Packing
Production labor	$253,000	$1,144,000	$396,000
Engineering support	22,000	50,600	24,200
Materials handling	19,800	19,800	29,700
Equipment maintenance	11,000	35,200	8,800
Laboratory expenses	22,000	22,000	4,400
Depreciation	44,000	176,000	52,800
Power	35,200	85,800	26,400
General and administrative	17,600	17,600	17,600
Total conversion costs	$424,600	$1,551,000	$559,900
Total number of process hours	8,760	35,040	8,760

Required

(a) Determine the estimated conversion cost driver rate per process hour for each stage. (Round to three digits after the decimal point.)

(b) Consider two of Connor Chemical's representative products, C206 and C208. Both products are derivatives of ethyl oleate and at the start of the process require the same basic raw materials. Using the information below, determine the total cost of a batch of C206 and a batch of C208:

	C206	C208
Materials:		
Raw materials, beginning of process	$1,488.00	$1,488.00
Packing materials	$175.20	$280.80
Conversion hours:		
Mixing and blending	6 hours	6 hours
Reaction chamber	24 hours	24 hours
Pulverizing and packing	4 hours	8 hours

LO 5, 6

4-47 ***Process costing equivalent units and product cost*** The information below pertains to October production at Zippy Company's bottling plant, which produces and bottles sports drinks. Each unit consists of a case of 12 bottles:

	Units	Materials	Conversion
Work in process, October 1	2,000	70% complete	60% complete
Started in October	10,000		
To account for	12,000		
Completed and transferred out	8,000	100% complete	100% complete
Work in process, October 30	4,000	40% complete	25% complete
Accounted for	12,000		
Costs, beginning of October		$1,050	$3,240
Added during October		8,200	22,620
To be accounted for		$9,250	$25,860

Required

(a) Using the weighted-average method, determine the number of equivalent units of production for materials and conversion during October.
(b) Determine the cost per equivalent unit for materials and conversion for October and the total cost per equivalent unit. (Round to two digits after the decimal point.)
(c) Determine whether the cost per equivalent unit for materials and conversion increased or decreased from the previous month.

LO 3, 6, 7 **(Appendix)** **4-48** ***Job bid and direct and sequential allocations*** Sanders Manufacturing Company produces electronic components on a job order basis. Most business is gained through bidding on jobs. Most firms competing with Sanders bid full cost plus a 30% markup. Recently, with the expectation of gaining more sales, Sanders dropped its markup from 40% to 30%. The company operates two service departments and two production departments. Manufacturing overhead costs and quantities of activities for each department are shown here:

	Service Departments		Production Departments	
Item	Personnel	Maintenance	Machining	Assembly
Overhead costs	$100,000	$200,000	$400,000	$300,000
Number of employees	5	5	5	40
Maintenance hours	1,500	200	7,500	1,000
Machine hours	0	0	10,000	1,000
Direct labor hours	0	0	1,000	10,000

Costs of the personnel department are allocated on the basis of employees and those of the maintenance department on the basis of maintenance hours. Departmental rates are used to assign overhead costs to products. The machining department uses machine hours, and the assembly department uses direct labor hours for this purpose.

The firm is preparing to bid on job 781, which requires three machine hours per unit produced in the machining department and five direct labor hours per unit produced in the assembly department. The expected direct materials and direct labor costs per unit are $450.

Required

(a) Allocate the service department costs to the production departments using the direct method.
(b) Determine the bid price per unit produced for job 781 using the direct method.
(c) Assume that the costs of the service department incurring the greatest cost are allocated first, and allocate the service department costs to the production departments using the sequential method. When allocating personnel costs, assume the maintenance department has 0 employees.
(d) Determine the bid price per unit produced for job 781 using the sequential method in part c.

LO 7 **(Appendix)** **4-49** ***Direct, sequential, and reciprocal allocation*** Boston Box Company has two service departments, maintenance and grounds, and two production departments, fabricating and assembly. Management has decided to allocate maintenance costs on the basis of machine hours used by the departments

and grounds costs on the basis of square feet occupied by the departments. The following data appear in the company's records for last year:

Item	Maintenance	Grounds	Fabricating	Assembly
Machine hours	0	1,500	12,000	6,000
Square feet	3,000	0	15,000	20,000
Costs	$18,000	$14,000	$45,000	$25,000

Required

(a) Allocate service department costs to the production departments using the direct method.
(b) Allocate service department costs to the production departments using the sequential method, assuming that the costs of the service department incurring the greatest cost are allocated first.
(c) Allocate service department costs to the production departments using the reciprocal method.

LO 3, 6, 7 **(Appendix)** **4-50** ***Job bid price and direct, sequential, and reciprocal allocations*** Sherman Company manufactures and sells small pumps made to customer specifications. It has two service departments and two production departments. Data on current year operations follow:

	Service Departments		Production Departments	
Item	Maintenance	Power	Casting	Assembly
Costs	$750,000	$450,000	$150,000	$110,000
Machine hours	0	80,000	80,000	40,000
Kilowatt-hours	40,000	0	200,000	160,000
Direct labor hours	0	0	100,000	60,000

Management allocates maintenance department costs using machine hours, and power department costs using kilowatt-hours. Separate cost driver rates are determined on the basis of machine hours for the casting department and on the basis of direct labor hours for the assembly department. It takes 1 machine hour to manufacture a pump in the casting department and 0.5 labor hour to assemble a pump in the assembly department. Direct labor and material costs amount to $32 per pump.

A prospective customer has requested a bid on a two-year contract to purchase 1,000 pumps every month. Sherman Company has a policy of adding a 25% markup to the full manufacturing cost to determine the bid.

Required

(a) What is the bid price when the direct method is used?
(b) What is the bid price when the sequential method that begins by allocating maintenance department costs is used?
(c) What is the bid price when the reciprocal method is used?

Cases

LO 3, 4 **4-51** ***Practical capacity, cost driver rates, and the death spiral*** Youngsborough Products, a supplier to the automotive industry, had seen its operating margins shrink below 20% as its customers put continued pressure on pricing. Youngsborough produced four products in its plant and decided to eliminate products that no longer contributed positive gross margins. The total plant overhead cost is $122,000 per year. Details on the four products are provided here:

	Products			
	A	B	C	D
Production volume (units)	10,000	8,000	6,000	4,000
Selling price	$15.00	$18.00	$20.00	$22.00
Materials per unit	$4.00	$5.00	$6.00	$7.00
Direct labor hours per unit	0.24	0.18	0.12	0.08
Total direct labor hours	2,400	1,440	720	320

Youngsborough calculates a plantwide overhead rate by dividing total direct labor hours into total overhead costs. Assume that plant overhead is a fixed cost during the year, but that direct labor is a variable cost. The direct labor rate is $30 per hour.

Required

(a) Calculate the plantwide cost driver rate and use this rate to assign overhead costs to products. Calculate the gross margin for each product and calculate the total gross margin.
(b) If any product is unprofitable in part a, drop this product from the mix. Recalculate the cost driver rate based on the new total direct labor hours remaining in the plant and use this rate to assign overhead costs to the remaining three products. Calculate the gross margin for each product and calculate the total gross margin.
(c) Drop any product that is unprofitable with the revised cost assignment. Repeat the process, eliminating any unprofitable products at each stage.
(d) What is happening at Youngsborough and why? How could this situation be avoided?

LO 2, 3, 4, 6 **4-52** ***Alternative job costing systems*** Over the past 15 years, Anthony's Auto Shop has developed a reputation for reliable repairs and has grown from a one-person operation to a nine-person operation, including one manager and eight skilled auto mechanics. In recent years, however, competition from mass merchandisers has eroded business volume and profits, leading the owner, Anthony Axle, to ask his manager to take a closer look at the cost structure of the auto shop.

The manager determined that direct materials (parts and components) are identified with individual jobs and charged directly to the customer. Direct labor (mechanics) is also identified with individual jobs and charged at a prespecified rate to the customers. The salary and benefits for a senior mechanic are $65,000 per year, and they are $45,000 per year for a junior mechanic. Each mechanic can work up to 1,750 hours in a year on customer jobs, but if there are not enough jobs to keep each of them busy, the cost of their compensation still will have to be incurred. The manager's salary and benefits amount to $75,000 per year. In addition, the following fixed costs are also incurred each year:

Rent	$40,000
Insurance	7,000
Utilities	7,000
Supplies	10,000
Machine maintenance	9,000
Machine depreciation	23,800
Total costs	$96,800

Because material costs are recovered directly from the customers, the profitability of the operation depends on the volume of business and the hourly rate charged for labor. At present, Anthony's Auto Shop charges $51.06 per hour for all jobs. Anthony said he would not consider firing any of the four senior mechanics because he believes it is difficult to get workers with their skills and loyalty to the firm, but he is willing to consider releasing one or two of the junior mechanics.

The present job costing system uses a single conversion rate for all jobs. The cost driver rate is currently determined by dividing estimated total labor and overhead costs by expected hours charged to customers. The eight mechanics are expected to be busy on customer jobs for 95% of the total available time. The price of $51.06 per hour is determined by adding a markup of x% to the cost driver rate, that is $\$51.06 = [1 + x/100] \times$ cost driver rate. Note that all personnel costs are included in conversion costs at present.

The manager is considering switching to the use of two rates, one for class A repairs and another for class B repairs. Electronic ignition system repairs or internal carburetor repairs are examples of class A repairs. Class A repairs require careful measurements and adjustments with equipment such as an oscilloscope or infrared gas analyzer. Class B repairs are simple repairs, such as shock absorber replacements or exhaust part replacements. Class A repairs can be done only by senior mechanics; class B repairs are done mainly by junior mechanics. Half of the hours charged to customers are expected to be for class A repairs, and the other half for class B repairs. Because class A repairs are expected to account for all of the senior mechanics' time and most of the machine usage, 60% of the total costs (including personnel costs) are attributable to class A repairs and the remaining 40% to class B repairs.

Required

(a) Determine the markup of x% currently used.

(b) Determine the two new rates, one for class A repairs and another for class B repairs, using the same markup of x% that you determined in part a.

(c) The following are expected labor hours anticipated for two customer jobs:

Job No.	Class A Repairs	Class B Repairs
101	4.5 hours	1.5 hours
102	None	2.0 hours

Determine the price (in addition to materials) to be charged for each of the two jobs under the present accounting system and under the proposed accounting system.

(d) What change in service mix is likely to result from the proposed price change?

(e) Provide reasons why Anthony might retain the current costing system or change to the proposed costing system.