For example, suppose that Jennifer determines that $400,000 of the fixed costs in Information Services is avoidable. When she evaluates bids from outside vendors, she can compare the avoidable costs from eliminating Information Services, $1,400,000 (= $1,000,000 variable costs + $400,000 avoidable fixed costs in Information Services) to the bid by the outside vendor.

Allocation of Joint Costs

joint cost
Cost of a manufacturing process with two or more outputs.

joint products
Outputs from a common input and common production process.

A **joint cost** is a cost of a manufacturing process with several different outputs. For example, coal of different quality can come from the same mine. The cost of mining the coal is a joint cost of these **joint products.** The problem in such cases is whether and how to allocate the joint cost of the input (for example, the cost of the mine) to the joint products (for example, hi-grade and lo-grade coal).

Joint Costing Defined

See Exhibit 11.14 for a diagram of the flow of costs incurred to mine coal for a month at CCC's Hilltop Mine. These costs include materials, labor, and manufacturing overhead (including allocated service department overhead). As the coal is mined, two products, hi-grade and lo-grade, emerge. (We ignore any other possible products for now.) The stage of processing at which the two products are separated is called the **split-off point.** Processing costs incurred prior to the split-off point are the *joint costs*.

split-off point
Stage of processing that separates two or more products.

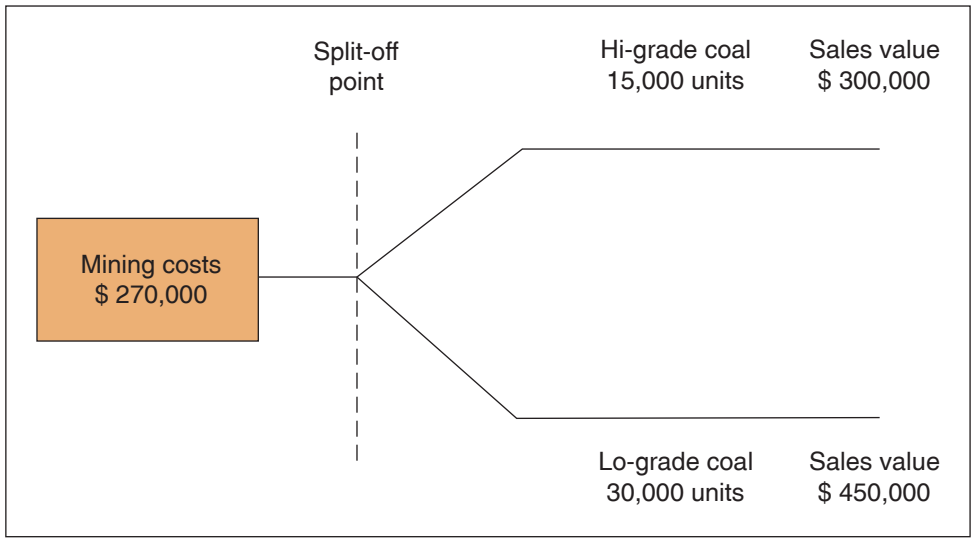
Managers often are interested in another issue. Should a product be sold at the split-off point or processed further? Rather than selling lo-grade coal at the split-off point, should CCC process it further to produce a higher quality of coal (mid-grade coal)? The higher-quality coal requires additional processing costs, but the sales price for mid-grade coal is higher than that for lo-grade coal sold at the split-off point.

L.O. 6
Explain why joint costs are allocated.

Reasons for Allocating Joint Costs

Joint costs are allocated for many reasons. Cost allocations are often used to determine departmental or division costs for evaluating executive performance. Many companies

Exhibit 11.14
Diagram of Joint Cost Flows—Carlyle Coal Company



compensate executives and other employees, at least partly, on the basis of departmental or division earnings for the year, as we discuss in Chapter 14. When a single raw material is converted into products sold by two or more departments, the cost of the raw material must be allocated to the products involved. For example, if different groups at CCC are responsible for selling hi-grade coal and lo-grade coal, the cost of mining coal could be allocated to these groups to compute group profit.

Manufacturing companies must allocate joint costs to determine the inventory value of the products that result from the joint process. When companies are subject to rate regulation, the allocation of joint costs can be a significant factor in determining the regulated rates. Crude oil and natural gas are usually produced from a common well. In recent years, energy price policies and gas utility rates have been based in part on the allocation of the joint costs of crude oil and natural gas.

When the allocation of costs can impinge on the financial fortunes of opposing parties, both sides critically review the allocation method. For example, neither an insurance company nor an insured party wishes to pay more or receive less than is fair. Executives and employees of one department object to a cost of goods sold figure that they believe is overstated for their department but understated for another department. Both buyers and sellers of regulated products or services are affected by pricing, and neither wishes to give the other an advantage. Each of these cases involves opposing interests.

As always, any cost allocation method contains an element of arbitrariness. No allocation method is beyond dispute. Consequently, allocation methods must be clearly stated before they are implemented.

Joint Cost Allocation Methods

The two major methods of allocating joint costs are (1) the net realizable value method and (2) the physical quantities method.

L.O. 7
Allocate joint costs using the net realizable value method.

Net Realizable Value Method

The **net realizable value method** allocates joint costs to products based on their net realizable values at the split-off point. The *net realizable value* is the estimated sales value of each product at the split-off point. If the joint products can be sold at the split-off point, the market value or sales price should be used for this allocation.

net realizable value method
Joint cost allocation based on the proportional values of the joint products at the split-off point.

If the products require further processing before they are marketable, it could be necessary to estimate the net realizable value at the split-off point. This approach is called the **estimated net realizable value,** sometimes referred to as the *netback* or *workback method*. Normally, when a market value is available at the split-off point, it is preferable to use that value rather than the estimated net realizable value method. If the market value is not available, the *net realizable value* at the split-off point is estimated by taking the sales value after further processing and deducting the additional processing costs. Joint costs are then allocated to the products in proportion to their net realizable values at the split-off point.

estimated net realizable value
Sales price of a final product minus additional processing costs necessary to prepare a product for sale.

We use the terms "net realizable value" and "estimated net realizable value" to emphasize that we are attempting to determine the value of the products at the split-off point. The difference is that in the former case (net realizable value), we can sell the product at the split-off point, so we do not have to estimate a value. You will see similar terms used in practice and textbooks, such as "sales value at split-off." As always with cost accounting terminology, it is important that you understand the concept referred to by the term and not just memorize the term itself.

We first consider an example of the *net realizable method*, and then we discuss the *estimated net realizable value* method in more detail.

Exhibit 11.15
Gross Margin Computations: Net Realizable Value Method

	A	B	C	D
1	**CARLYLE COAL COMPANY**			
2	**For the Month of March**			
3		Hi-Grade	Lo-Grade	Total
4	Sales value	$ 300,000	$ 450,000	$ 750,000
5	Less allocated joint costs	108,000	162,000	270,000
6	Gross margin	$ 192,000	$ 288,000	$ 480,000
7	Gross margin as a percent of sales	64%	64%	64%
8				

From the information in Exhibit 11.14, we know that CCC produces hi-grade and lo-grade coal. In March, joint mining costs (materials, labor, and overhead) totaled $270,000. Hi-grade and lo-grade coal have a $750,000 total sales value at the split-off point. Hi-grade has a $300,000 sales value, or 40 percent of the total, and lo-grade's value is $450,000, or 60 percent of the total. We assume for the purpose of this example that no additional processing is required after the split-off point to process either grade of coal.

The cost allocation follows the proportional distribution of net realizable values:

	A	B	C	D
1		Hi-Grade	Lo-Grade	Total
2	Final sales value	$ 300,000	$ 450,000	$ 750,000
3	Less additional processing costs	–0–	–0–	–0–
4	Net realizable value at split-off point	$ 300,000	$ 450,000	$ 750,000
5	Proportionate share			
6	= $ 300,000/$ 750,000 (B4/D4)	40%		
7	= $ 450,000/$ 750,000 (C4/D4)		60%	
8	Allocated joint costs			
9	= $ 270,000 × 40%	$ 108,000		
10	= $ 270,000 × 60%		$ 162,000	
11				

See Exhibit 11.15 for a condensed statement of gross margins at the split-off point.

Note that the gross margin as a percentage of sales is 64 percent for both products. This demonstrates an important concept of the net realizable value method, namely, that revenue dollars from any joint product are assumed to make the same percentage contribution at the split-off point as the revenue dollars from any other joint product. The net realizable value approach implies a matching of input costs with revenues generated by each output.

Self-Study Question

4. Thumb Beets, Inc., grows sugar beets. After the beets are harvested, they are processed into sugar and livestock feed. One ton of sugar beets yields 0.2 tons of sugar and 0.4 tons of feed. The sugar can be sold for $400 per ton and the feed for $200 per ton at the split-off point. The cost of the sugar beets is $60 per ton (2,000 pounds). Processing each ton of beets up to the split-off point costs $40 in labor and overhead.

   Compute the joint cost allocated to sugar and feed produced from 10 tons of sugar beets using the net realizable value method.

The solution to this question is at the end of the chapter on page 437.

Estimation of Net Realizable Value In the previous example, we assumed that no further processing was required after the split-off point. Not all joint products can be

sold at the split-off point, however. Additional processing could be required before a product is marketable. When no sales values exist for the outputs at the split-off point, the *estimated net realizable values* should be determined by taking the sales value of each product at the first point at which it can be marketed and deducting the processing costs that must be incurred after the split-off point. The resulting estimated net realizable value is used for joint cost allocation in the same way as an actual market value at the split-off point.

Suppose that CCC management finds excellent opportunities to sell a refined product, mid-grade coal, but selling it requires that CCC do additional processing to the lo-grade coal that comes from the mine. Also assume that no market exists for this lo-grade coal. This additional processing costs $50,000 for the mid-grade coal produced in March, after which it could be sold for $550,000. The hi-grade coal could still be sold at the split-off point for $300,000. See Exhibit 11.16 for a diagram of the process.

See Exhibit 11.17 for the allocation of the joint cost of $270,000 to hi-grade and mid-grade coal using the estimated net realizable value method. First, we compute the estimated net realizable values at split-off for hi-grade and mid-grade coal, which are $300,000 and $500,000, respectively. Next we multiply the ratio of each product's net realizable value to the total estimated net realizable value by the joint cost. To determine the portion of the joint cost allocated to hi-grade coal, for example, the computations are ($300,000 ÷ $800,000) times the joint cost of $270,000 (37.5% × $270,000 = $101,250), as shown in Exhibit 11.17.

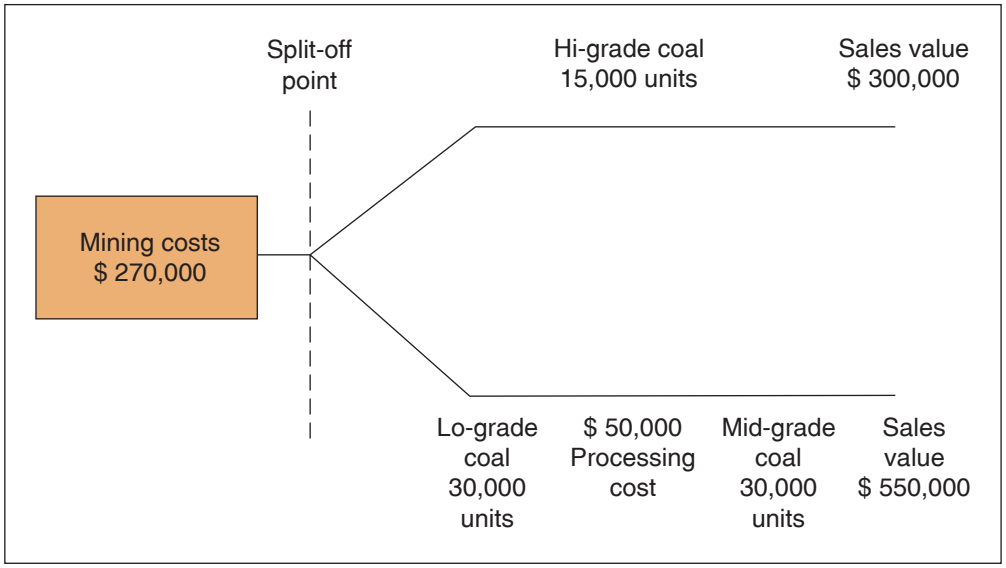


Exhibit 11.16
Further Processing of Coal: Cost Flows—Carlyle Coal Company

	A	B	C	D
1	**CARLYLE COAL COMPANY**			
2	**For the Month of March**			
3		Hi-Grade	Mid-Grade	Total
4	Sales value	$ 300,000	$ 550,000	$ 850,000
5	Less additional cost to process to mid-grade coal	–	50,000	50,000
6	Estimated net realizable value at split-off	$ 300,000	$ 500,000	$ 800,000
7	Allocation of joint costs			
8	($ 300,000/$ 800,000) × $ 270,000 = 37.5% × $ 270,000	101,250	–	101,250
9	($ 500,000/$ 800,000) × $ 270,000 = 62.5% × $ 270,000	–	168,750	168,750
10	Gross margin	$ 198,750	$ 331,250	$ 530,000
11	Gross margin as a percent of sales	66%	60%	62%
12				

Exhibit 11.17
Gross Margin Computations Using Net Realizable Value Method: Further Processing

Self-Study Question

5. Refer to Self-Study Question 4. Assume that the sugar cannot be sold at split-off but requires additional processing. The additional processing costs $100 per ton, at which point the sugar can be sold for $450 per ton. Allocate the joint costs to the two products using the estimated net realizable value method.

The solution to this question is at the end of the chapter on page 437.

L.O. 8
Allocate joint costs using the physical quantities method.

physical quantities method
Joint cost allocation based on measurement of the volume, weight, or other physical measure of the joint products at the split-off point.

Physical Quantities Method

The **physical quantities method** of allocation is often used when output product prices are highly volatile. This method is also used when significant processing occurs between the split-off point and the first point of marketability or when product prices are not set by the market. The latter situation could occur when regulators set prices or in cost-based contract situations, for example.

Using the physical quantities method, joint costs are assigned to products based on a physical measure. This could be volume, weight, or any other common measure of physical characteristics.

Many companies allocate joint costs incurred in producing oil and gas on the basis of energy equivalent (BTU content). They use this method because the products are typically measured in different physical units (gas by thousand cubic feet, oil by barrel), although oil and gas often are produced simultaneously from the same well. Moreover, the price of most gas is regulated so that relative market values are artificial.

Let's return to the original CCC example; the company only produces hi-grade and lo-grade coal. Assume that relative market values at the split-off point are not available and for every $270,000 of joint costs in processing coal, we obtain 15,000 tons of hi-grade and 30,000 tons of lo-grade coal. See Exhibit 11.18 for the allocation of joint costs using the physical quantities method. A total of 45,000 tons is produced. Joint costs are allocated to hi-grade coal by dividing tons of it (15,000) by the total units mined (45,000) and multiplying the result by total joint costs ($270,000). Thus, $90,000 in joint costs is allocated to hi-grade coal.

Evaluation of Joint Cost Methods

The "jointness" of joint production processes makes it impossible to separate the portion of joint costs attributable to one product from another on a cause-and-effect basis. As a result, allocating joint costs is always somewhat arbitrary, although it is often done in

Exhibit 11.18
Gross Margin Computations: Physical Quantities Method

	A	B	C	D
1	**CARLYLE COAL COMPANY**			
2	**For the Month of March**			
3		Hi-Grade	Lo-Grade	Total
4	Quantity (tons)	15,000	30,000	45,000
5				
6	Sales value	$ 300,000	$ 450,000	$ 750,000
7	Allocation of joint costs			
8	(15,000/45,000) × $ 270,000 = 33.3% × $ 270,000	90,000	–0–	90,000
9	(30,000/45,000) × $ 270,000 = 66.7% × $ 270,000	–0–	180,000	180,000
10	Gross margin	$ 210,000	$ 270,000	$ 480,000
11	Gross margin as a percent of sales	70%	60%	64%
12				

practice. If allocated joint costs are used for decision-making purposes, they should be used only with full recognition of their limitations. Accountants and managers realize that no one allocation method is appropriate for all situations.

Self-Study Question

6. Refer to Self-Study Question 4. Use the physical quantities method to allocate joint costs.

The solution to this question is at the end of the chapter on page 437.

Deciding Whether to Sell Goods Now or Process Them Further

L.O. 9
Explain how cost data are used in the sell-or-process-further decision.

Many companies have opportunities to sell partly processed products at various production stages. Management must decide whether it is more profitable to sell the output at an intermediate stage or to process it further. In such a sell-or-process-further decision, the relevant data to be considered are (1) the additional revenue after further processing and (2) the additional costs of processing further. This is simply an application of the differential analysis approach discussed in Chapter 4.

Returning to our original example, suppose that CCC can sell lo-grade coal for $450,000 at the split-off point or process it further to make a new product, mid-grade coal. The additional processing costs would be $50,000, and the revenue from mid-grade coal produced in March would be $550,000. Should the company sell lo-grade coal or process it further?

CCC's profit will be $50,000 higher if lo-grade coal is processed further into mid-grade coal (see Exhibit 11.19). It is important to note that the allocation of the $270,000 joint costs between hi-grade and lo-grade coal is irrelevant. The $100,000 additional revenue from processing beyond the split-off point justifies the expenditure of $50,000 for additional processing, regardless of the way joint costs are allocated. *The only costs and revenues relevant to the decision are those that result from it*. Total joint costs incurred prior to the split-off point are not affected by the decision to process further after the split-off point.

We can summarize the sell-or-process-further decision as:

Sell at split-off if: Sales value at split-off $>$ Sales value after processing, less additional processing costs

Process further if: Sales value at split-off $<$ Sales value after processing, less additional processing costs

Exhibit 11.19 Differential Analysis of the Sell-or-Process-Further Decision—Carlyle Coal Company

	Sell Lo-Grade Coal	Process Further (Mid-Grade)	Additional Revenue and Costs from Processing Further	
Revenues	$450,000	$550,000	$100,000	
Less separate processing costs	–0–	50,000	50,000	
Margin	$450,000	$500,000	$ 50,000	Net gain from processing further

In Action **Different Demands for Different Parts**

In the case of coal, when demand increases for one product, the other (joint) product can be stored until demand catches up. However, in the case of fresh meat and produce, long-term storage might not be economically feasible. This creates a problem when the demand for one part increases and the firm has to decide whether it is worthwhile meeting that demand.

For example, an Asian chicken producer is organized according to the part of the chicken being sold. (Because different cultures favor different parts, some parts are delivered fresh while others are frozen.) The company often faces a problem when the marketing managers from one group (for example, legs) want to increase production because of increased demand. In such cases, the increased production means that the other parts (for example, wings) have to be sold for less. The firm wanted the managers from the group selling legs to consider the depression of prices for wings. By allocating according to net realizable value, the group selling legs now bears a higher percentage of the joint costs because the revenue from selling legs rises relative to that of wings.

While the allocation remains arbitrary, there is now a built-in incentive to signal the impact of increased production of one part on the company's overall profits.

Source: Based on the authors' research.

Deciding What to Do with By-Products

L.O. 10
Account for by-products.

by-products
Outputs of joint production processes that are relatively minor in quantity or value.

By-products are outputs from a joint production process that are relatively minor in quantity and/or value when compared to the main products. For example, coal dust, which can be mixed with water to produce a low-quality fuel, is a by-product of coal mining, and kerosene is a by-product of gasoline production. You probably have seen advertisements for carpet and cloth mill ends at bargain prices. These are often by-products of textile production.

Accounting for by-products attempts to reflect the economic relationship between the by-products and the main products with a minimum of recordkeeping for inventory valuation purposes. The two common methods of accounting for by-products are

- *Method 1*: The net realizable value from sale of the by-product is deducted from the joint costs, effectively allocating to the by-product an amount of joint cost equal to the sales value of the by-product. The remaining joint costs are allocated to the main products.
- *Method 2*: The proceeds from sale of the by-product are treated as other revenue. All joint costs are allocated to the main products.

Assume that in March Carlyle Coal Company produced 3,000 tons of coal dust (along with the 15,000 tons of hi-grade coal and 30,000 tons of lo-grade coal). Sales of coal dust total $15,000. All other revenues and costs are as described in Exhibit 11.15.

See Panel A of Exhibit 11.20 for the computation of the gross margin for the two joint products when the net realizable value of the by-product is used to reduce the joint cost (method 1). The $270,000 in joint cost is reduced by the by-product's $15,000 sales value so $255,000 (= $270,000 − $15,000) is allocated to hi-grade and lo-grade coal. Applying method 2 results in no effect on the gross margins of the major products; the by-product shows a gross margin equal to its revenue (see Panel B).

A complication can occur under both methods if the cost of processing by-products occurs in one period but they are not sold until the next period. In such a case, companies could find it necessary to keep an inventory of the by-product processing costs in the Additional By-Product Cost account until the by-products are sold.

In our experience, some companies make by-product accounting as easy as possible by expensing the by-products' costs in the period in which they are incurred and then recording the total revenue from them when they are sold. Using this method, the accountants do not have to keep an inventory of by-product processing costs, nor do they have to compute their net realizable value. Although this simple approach technically violates the principle that revenues and expenses should be matched in the same accounting period, the amounts involved are generally immaterial.

Exhibit 11.20 Gross Margin Computations Using Net Realizable Value Method for Allocating Joint Cost with By-Products

	A	B	C	D	E
1	**CARLYLE COAL COMPANY**				
2	**For the Month of March**				
3					
4	**Panel A: Method 1**	Hi-Grade	Lo-Grade	Dust	
5	Sales value	$ 300,000	$ 450,000	$ 15,000	$ 765,000
6	Less additional processing costs	–0–	–0–	–0–	–0–
7	Net realizable value at split-off point	$ 300,000	$ 450,000	$ 15,000	$ 765,000
8	Deduct sales value of by-product:			15,000	15,000
9	Proportionate share of remaining joint cost:				
10	$ 300,000/$ 750,000	40%			
11	$ 450,000/$ 750,000		60%		
12	Allocated joint costs				
13	($ 270,000 − $ 15,000) × 40%	$ 102,000			$ 102,000
14	($ 270,000 − $ 15,000) × 60%	–0–	$ 153,000	–0–	153,000
15	Gross margin	$ 198,000	$ 297,000	$ –0–	$ 495,000
16	Gross margin as a percent of sales	66%	66%	–0–%	65%
17					
18					
19	**Panel B: Method 2**				
20	Sales value	$ 300,000	$ 450,000	$ 15,000	$ 765,000
21	Less additional processing costs	–0–	–0–	–0–	–0–
22	Net realizable value at split-off point	$ 300,000	$ 450,000	$ 15,000	$ 765,000
23	Proportionate share of remaining joint cost:				
24	$ 300,000/$ 750,000	40%			
25	$ 450,000/$ 750,000		60%		
26	Allocated joint costs				
27	($ 270,000) × 40%	$ 108,000	–0–	–0–	$ 108,000
28	($ 270,000) × 60%	–0–	$ 162,000	–0–	162,000
29	Gross margin	$ 192,000	$ 288,000	$ 15,000	$ 495,000
30	Gross margin as a percent of sales	64%	64%	100%	65%
31					

The Debrief

Jennifer King, the marketing team member from cost accounting, has returned after considering the choices for allocating costs at CCC:

> Wow! I knew that there was an element of arbitrariness in cost allocation, but when you consider all the choices we have, you can't just say any one method will do as well as any other. I am recommending that we use the reciprocal method for allocating our service department costs. We hadn't allocated them at all before, so we are unlikely to affect managers who might be used to a particular approach.
>
> The reciprocal method will also help me make a decision about what to do with Information Services. We will go out for bids to managed service providers and see if they can do it for less than it costs us. At least I now have a good estimate of our costs.
>
> I recommend the net realizable value method for allocating our joint costs. We tend to focus on the hi-grade product here and, by placing more costs on that product, I hope we can keep managers thinking about how to bring down our costs. Finally, because the value of our by-product is pretty low, I recommend that we use method 1 for accounting for the slurry. That is, we will deduct the net realizable value from the sale of the by-product from the joint cost.

Although we have indicated that two methods are used to account for by-products, many variations of these methods are used in practice. By-products are by definition relatively minor products; hence, alternative methods to account for them are not likely to have a material effect on the financial statements for either internal or external reporting.

Summary

Cost allocation is the process of assigning common costs to two or more cost objects. Ideally, cost allocation reflects a cause-and-effect relation between costs and the objects to which they are allocated.

Service department cost allocations are required to ensure that the costs of support services are included in the costs of products. The three major methods of service department cost allocation are the direct method, the step method, and the reciprocal method. The methods differ by the extent to which services provided by one service department to another are considered in the allocation process.

Joint cost allocations arise from the need to assign common costs to two or more products manufactured from a common input. The usual objective of joint cost allocation is to relate the costs of the inputs to the economic benefits received. There is no direct way to do this for joint products, so approximations are necessary. The two methods of joint cost allocation distribute joint costs based on the use of the net realizable value method (or *estimated* net realizable value) or the physical quantities method. These methods are acceptable for financial reporting purposes, but care must be exercised before attempting to use the data for decision-making purposes because of the inherent arbitrariness in joint cost allocations.

The following summarize the chapter's key ideas tied to the chapter's learning objectives.

L.O. 1. Explain why service costs are allocated. Costs are allocated to inform managers about the costs of running departments that use the services of other departments. Cost allocations are required for external financial reporting and tax purposes.

L.O. 2. Allocate service department costs using the direct method. The direct method allocates service department costs to user departments and ignores any services used by other service departments.

L.O. 3. Allocate service department costs using the step method. Based on an allocation order, the step method allocates service department costs to other service departments and then to production departments. Once an allocation is made from a service department, no further costs are allocated back to that department.

L.O. 4. Allocate service department costs using the reciprocal method. The reciprocal method allows for the simultaneous allocation of service department costs to and from all other service departments.

L.O. 5. Use the reciprocal method for decisions. By applying the reciprocal methods to the variable costs in the service departments, the resulting costs for these departments provide an estimate of the total variable cost of each service department, accounting for the reciprocal use of other service departments.

L.O. 6. Explain why joint costs are allocated. Joint costs are allocated to assign common costs to two or more products manufactured from a common input. Companies allocate costs to establish a cost basis for pricing or performance evaluation.

L.O. 7. Allocate joint costs using the net realizable value method. The net realizable value method allocates joint costs to products in proportion to their relative sales values. If additional processing is required beyond the split-off point before the product can be sold, an estimate of the net realizable value can be derived at the split-off point by subtracting the additional processing costs from the estimated sales value.

L.O. 8. Allocate joint costs using the physical quantities method. The physical quantities method allocates joint costs to products in proportion to a physical measure (for example, volume or weight).

L.O. 9. Explain how cost data are used in the sell-or-process-further decision. Management must often decide whether to sell products at split-off points or process them further. Joint cost allocations are usually irrelevant for these decisions.