16 Cost Allocation: Joint Products and Byproducts

Learning Objectives

1. Identify the splitoff point in a joint-cost situation and distinguish joint products from byproducts
2. Explain why joint costs are allocated to individual products
3. Allocate joint costs using four methods
4. Explain when the sales value at splitoff method is preferred when allocating joint costs
5. Explain why joint costs are irrelevant in a sell-or-process-further decision
6. Account for byproducts using two methods

Many companies, such as petroleum refiners, produce and sell two or more products simultaneously.

Similarly, some companies, such as health care providers, sell or provide multiple services. The question is, "How should these companies allocate costs to 'joint' products and services?" Knowing how to allocate joint product costs isn't something that only companies need to understand. It's something that farmers have to deal with, too, especially when it comes to the lucrative production of corn to make billions of gallons of ethanol fuel.

Joint Cost Allocation and the Production of Ethanol Fuel[1]

The increased global demand for oil has driven prices higher and forced countries to look for environmentally-sustainable alternatives. In the United States, the largest source of alternative fuel comes from corn-based ethanol. In 2009, the U.S. produced 10.75 billion gallons of ethanol, or 55% of the world's production, up from 1.7 billion gallons per year in 2001.

Producing ethanol requires a significant amount of corn. In 2011, the U.S. Department of Agriculture predicts that more than one-third of U.S. domestic corn production will be used to create ethanol fuel. But not all of that corn winds up in the ethanol that gets blended into gasoline and sold at service station.

Most biotechnology operations, such as making ethanol, produce two or more products. While distilling corn into ethanol, cell mass from the process—such as antibiotic and yeast fermentations—separates from the liquid and becomes a separate product, which is often sold as animal feed. This separation point, where outputs become distinctly identifiable, is called the splitoff point. Similarly, the residues from corn processing plants create secondary products including distillers' dried grains and gluten.

Accountants refer to these secondary products as byproducts. Ethanol byproducts like animal feed and gluten are accounted for by deducting the income from selling these products from the cost of ethanol fuel, the major product. With ethanol production costing

[1] *Sources:* Hacking, Andrew. 1987. *Economic aspects of biotechnology*. Cambridge, United Kingdom: Cambridge University Press; Leber, Jessica. 2010. Economics improve for first commercial cellulosic ethanol plants. *New York Times*, February 16; *USDA Agricultural Predictions to 2019*. 2010. Washington, DC: Government Printing Office; PBS. 2006. Glut of ethanol byproducts coming. *The Environmental Report*, Spring; *Entrepreneur*. 2007. Edible ethanol byproduct is source of novel foods. August.

around $2 per gallon and byproducts selling for a few cents per pound, most of the costs of production are allocated to the ethanol fuel itself, the main product. Since manufacturers would otherwise have to pay to dispose of their ethanol byproducts, most just try to "break even" on byproduct revenue.

In the coming years, however, this may change. With ethanol production growing, corn-based animal feed byproducts are becoming more plentiful. Some ethanol manufacturers are working together to create a market for ethanol feed, which is cheaper and higher in protein than plain corn. This allows ranchers' animals to gain weight faster and at a lower cost per pound. Additionally, scientists are trying to create an edible byproduct from distillers' dry grains, which could become a low-calorie, low-carbohydrate substitute in foods like breads and pastas.

Accounting concerns similar to those in the ethanol example also arise when traditional energy companies like ExxonMobil simultaneously produce crude oil, natural gas, and raw liquefied petroleum gas (LPS) from petroleum, in a single process. This chapter examines methods for allocating costs to joint products. We also examine how cost numbers appropriate for one purpose, such as external reporting, may not be appropriate for other purposes, such as decisions about the further processing of joint products.

Joint-Cost Basics

Joint costs are the costs of a production process that yields multiple products simultaneously. Consider the distillation of coal, which yields coke, natural gas, and other products. The costs of this distillation are joint costs. The **splitoff point** is the juncture in a joint production process when two or more products become separately identifiable. An example is the point at which coal becomes coke, natural gas, and other products. **Separable costs** are all costs—manufacturing, marketing, distribution, and so on—incurred beyond the splitoff point that are assignable to each of the specific products identified at the splitoff point. At or beyond the splitoff point, decisions relating to the sale or further processing of each identifiable product can be made independently of decisions about the other products.

Industries abound in which a production process simultaneously yields two or more products, either at the splitoff point or after further processing. Exhibit 16-1 presents examples of joint-cost situations in diverse industries. In each of these examples, no individual product can be produced without the accompanying products appearing, although in some cases the proportions can be varied. The focus of joint costing is on allocating costs to individual products at the splitoff point.

The outputs of a joint production process can be classified into two general categories: outputs with a positive sales value and outputs with a zero sales value.[2] For

Learning Objective 1

Identify the splitoff point in a joint-cost situation

. . . the point at which two or more products become separately identifiable

and distinguish joint products

. . . products with high sales values

from byproducts

. . . products with low sales values

[2] Some outputs of a joint production process have "negative" revenue when their disposal costs (such as the costs of handling nonsalable toxic substances that require special disposal procedures) are considered. These disposal costs should be added to the joint production costs that are allocated to joint or main products.

Exhibit 16-1

Examples of Joint-Cost Situations

Industry	Separable Products at the Splitoff Point
Agriculture and Food Processing Industries	
Cocoa beans	Cocoa butter, cocoa powder, cocoa drink mix, tanning cream
Lambs	Lamb cuts, tripe, hides, bones, fat
Hogs	Bacon, ham, spare ribs, pork roast
Raw milk	Cream, liquid skim
Lumber	Lumber of varying grades and shapes
Turkeys	Breast, wings, thighs, drumsticks, digest, feather meal, and poultry meal
Extractive Industries	
Coal	Coke, gas, benzol, tar, ammonia
Copper ore	Copper, silver, lead, zinc
Petroleum	Crude oil, natural gas
Salt	Hydrogen, chlorine, caustic soda
Chemical Industries	
Raw LPG (liquefied petroleum gas)	Butane, ethane, propane
Crude oil	Gasoline, kerosene, benzene, naphtha
Semiconductor Industry	
Fabrication of silicon-wafer chips	Memory chips of different quality (as to capacity), speed, life expectancy, and temperature tolerance

example, offshore processing of hydrocarbons yields oil and natural gas, which have positive sales value, and it also yields water, which has zero sales value and is recycled back into the ocean. The term **product** describes any output that has a positive total sales value (or an output that enables a company to avoid incurring costs, such as an intermediate chemical product used as input in another process). The total sales value can be high or low.

When a joint production process yields one product with a high total sales value, compared with total sales values of other products of the process, that product is called a **main product**. When a joint production process yields two or more products with high total sales values compared with the total sales values of other products, if any, those products are called **joint products**. The products of a joint production process that have low total sales values compared with the total sales value of the main product or of joint products are called **byproducts**.

Consider some examples. If timber (logs) is processed into standard lumber and wood chips, standard lumber is a main product and wood chips are the byproduct, because standard lumber has a high total sales value compared with wood chips. If, however, logs are processed into fine-grade lumber, standard lumber, and wood chips, fine-grade lumber and standard lumber are joint products, and wood chips are the byproduct. That's because both fine-grade lumber and standard lumber have high total sales values when compared with wood chips.

Decision Point

What do the terms joint cost and splitoff point mean, and how do joint products differ from byproducts?

Distinctions among main products, joint products, and byproducts are not so definite in practice. For example, some companies may classify kerosene obtained when refining crude oil as a byproduct because they believe kerosene has a low total sales value relative to the total sales values of gasoline and other products. Other companies may classify kerosene as a joint product because they believe kerosene has a high total sales value relative to the total sales values of gasoline and other products. Moreover, the classification of products—main, joint, or byproduct—can change over time, especially for products such as lower-grade semiconductor chips, whose market prices may increase or decrease by 30% or more in a year. When prices of lower-grade chips are high, they are considered joint products together with higher-grade chips; when prices of lower-grade chips fall considerably, they are considered byproducts. In practice, it is important to understand how a specific company chooses to classify its products.

Allocating Joint Costs

Before a manager is able to allocate joint costs, she must first look at the context for doing so. There are several contexts in which joint costs are required to be allocated to individual products or services. These include the following:

- Computation of inventoriable costs and cost of goods sold. Recall from Chapter 9 that absorption costing is required for financial accounting and tax reporting purposes. This necessitates the allocation of joint manufacturing or processing costs to products for calculating ending inventory values.
- Computation of inventoriable costs and cost of goods sold for internal reporting purposes. Many firms use internal accounting data based on joint cost allocations for the purpose of analyzing divisional profitability and in order to evaluate division managers' performance.
- Cost reimbursement for companies that have a few, but not all, of their products or services reimbursed under cost-plus contracts with, say, a government agency. In this case, stringent rules typically specify the manner in which joint costs are assigned to the products or services covered by the cost-plus agreement. That said, fraud in defense contracting, which is often done via cost-plus contracts, remains one of the most active areas of false claim litigation under the Federal False Claims Act. A common practice is "cross-charging," where a contractor shifts joint costs from "fixed-price" defense contracts to those that are done on a cost-plus basis. Defense contractors have also attempted to secure contracts from private businesses or foreign governments by allocating an improper share of joint costs onto the cost-plus agreements they have with the United States government.[3]
- Rate or price regulation for one or more of the jointly produced products or services. This issue is conceptually related to the previous point, and is of great importance in the extractive and energy industries where output prices are regulated to yield a fixed return on a cost basis that includes joint cost allocations. In telecommunications, for example, it is often the case that a firm with significant market power has some products subject to price regulation (e.g., interconnection) and other activities that are unregulated (such as end-user equipment rentals). In this case, it is critical in allocating joint costs to ensure that costs are not transferred from unregulated services to regulated ones.[4]
- Insurance-settlement computations for damage claims made on the basis of cost information of jointly produced products. In this case, the joint cost allocations are essential in order to provide a cost-based analysis of the loss in value.
- More generally, any commercial litigation situation in which costs of joint products or services are key inputs requires the allocation of joint costs.

Learning Objective 2

Explain why joint costs are allocated to individual products

. . . to calculate cost of goods sold and inventory, and for reimbursements under cost-plus contracts and other types of claims

Decision Point

Why are joint costs allocated to individual products?

Approaches to Allocating Joint Costs

Two approaches are used to allocate joint costs.

- **Approach 1.** Allocate joint costs using *market-based* data such as revenues. This chapter illustrates three methods that use this approach:
  1. Sales value at splitoff method
  2. Net realizable value (NRV) method
  3. Constant gross-margin percentage NRV method
- **Approach 2.** Allocate joint costs using *physical measures*, such as the weight, quantity (physical units), or volume of the joint products.

In preceding chapters, we used the cause-and-effect and benefits-received criteria for guiding cost-allocation decisions (see Exhibit 14-2, p. 505). Joint costs do not have a cause-and-effect relationship with individual products because the production process simultaneously yields multiple products. Using the benefits-received criterion leads to a preference for methods under approach 1 because revenues are, in general, a better

Learning Objective 3

Allocate joint costs using four methods

. . . sales value at splitoff, physical measure, net realizable value (NRV), and constant gross-margin percentage NRV

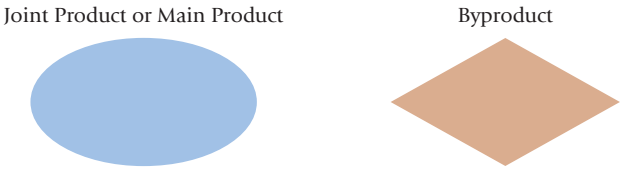
[3] See, for example, www.dodig.mil/iginformation/IGInformationReleases/3eSettlementPR.pdf

[4] For details, see the International Telecommunication Union's ICT Regulation Toolkit at www.ictregulationtoolkit.org/en/Section.3497.html.

indicator of benefits received than physical measures. Mining companies, for example, receive more benefits from 1 ton of gold than they do from 10 tons of coal.

In the simplest joint production process, the joint products are sold at the splitoff point without further processing. Example 1 illustrates the two methods that apply in this case: the sales value at splitoff method and the physical-measure method. Then we introduce joint production processes that yield products that require further processing beyond the splitoff point. Example 2 illustrates the NRV method and the constant-gross margin percentage NRV method. To help you focus on key concepts, we use numbers and amounts that are smaller than the numbers that are typically found in practice.

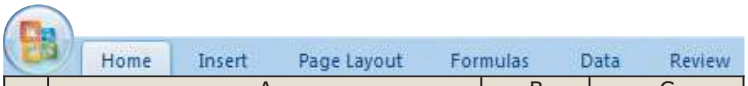
The exhibits in this chapter use the following symbols to distinguish a joint or main product from a byproduct:



To compare methods, we report gross-margin percentages for individual products under each method.

Example 1: Farmers' Dairy purchases raw milk from individual farms and processes it until the splitoff point, when two products—cream and liquid skim—emerge. These two products are sold to an independent company, which markets and distributes them to supermarkets and other retail outlets.

In May 2012, Farmers' Dairy processes 110,000 gallons of raw milk. During processing, 10,000 gallons are lost due to evaporation and spillage, yielding 25,000 gallons of cream and 75,000 gallons of liquid skim. Summary data follow:



	A	B	C
1		**Joint Costs**	
2	Joint costs (costs of 110,000 gallons raw milk and processing to splitoff point)	$400,000	
3			
4		**Cream**	**Liquid Skim**
5	Beginnning inventory (gallons)	0	0
6	Production (gallons)	25,000	75,000
7	Sales (gallons)	20,000	30,000
8	Ending inventory (gallons)	5,000	45,000
9	Selling price per gallon	$ 8	$ 4

Exhibit 16-2 depicts the basic relationships in this example.

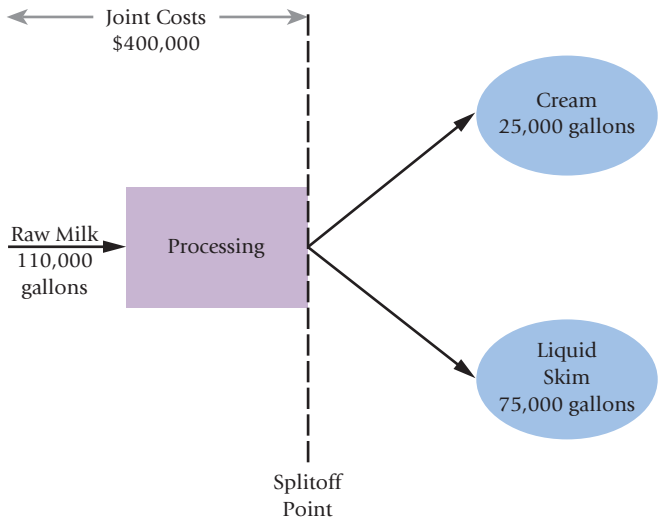
How much of the $400,000 joint costs should be allocated to the cost of goods sold of 20,000 gallons of cream and 30,000 gallons of liquid skim, and how much should be allocated to the ending inventory of 5,000 gallons of cream and 45,000 gallons of liquid skim? We begin by illustrating the two methods that use the properties of the products at the splitoff point, the sales value at splitoff method and the physical-measure method.

Sales Value at Splitoff Method

The **sales value at splitoff method** allocates joint costs to joint products produced during the accounting period on the basis of the relative total sales value at the splitoff point. Using this method for Example 1, Exhibit 16-3, Panel A, shows how joint costs

Exhibit 16-2

Example 1: Overview of Farmers' Dairy



are allocated to individual products to calculate cost per gallon of cream and liquid skim for valuing ending inventory. This method uses the sales value of the *entire production of the accounting period* (25,000 gallons of cream and 75,000 gallons of liquid skim), not just the quantity sold (20,000 gallons of cream and 30,000 gallons of liquid skim). The reason this method does not rely solely on the quantity sold is that the joint costs were incurred on all units produced, not just the portion sold during the current period. Exhibit 16-3, Panel B, presents the product-line income statement using the sales value at splitoff method. Note that the gross-margin percentage for each product is 20%, because the sales value at splitoff method allocates joint costs to each product in proportion to the sales value of total production (cream: $160,000 ÷ $200,000 = 80%; liquid skim: $240,000 ÷ $300,000 = 80%). Therefore, the gross-margin percentage for each product manufactured in May 2012 is the same: 20%.[5]

Note how the sales value at splitoff method follows the benefits-received criterion of cost allocation: Costs are allocated to products in proportion to their revenue-generating

Exhibit 16-3 Joint-Cost Allocation and Product-Line Income Statement Using Sales Value at Splitoff Method: Farmers' Dairy for May 2012

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	A	B	C	D
1	**PANEL A: Allocation of Joint Costs Using Sales Value at Splitoff Method**	**Cream**	**Liquid Skim**	**Total**
2	Sales value of total production at splitoff point			
3	(25,000 gallons × $8 per gallon; 75,000 gallons × $4 per gallon)	$200,000	$300,000	$500,000
4	Weighting ($200,000 ÷ $500,000; $300,000 ÷ 500,000)	0.40	0.60	
5	Joint costs allocated (0.40 × $400,000; 0.60 × $400,000)	$160,000	$240,000	$400,000
6	Joint production cost per gallon			
7	($160,000 ÷ 25,000 gallons; $240,000 ÷ 75,000 gallons)	$ 6.40	$ 3.20	
8				
9	**PANEL B: Product-Line Income Statement Using Sales Value at Splitoff Method for May 2012**	**Cream**	**Liquid Skim**	**Total**
10	Revenues (20,000 gallons × $8 per gallon; 30,000 gallons × $4 per gallon)	$160,000	$120,000	$280,000
11	Cost of goods sold (joint costs)			
12	Production costs (0.40 × $400,000; 0.60 × $400,000)	160,000	240,000	400,000
13	Deduct ending inventory (5,000 gallons × $6.40 per gallon; 45,000 gallons × $3.20 per gallon)	32,000	144,000	176,000
14	Cost of goods sold (joint costs)	128,000	96,000	224,000
15	Gross margin	$ 32,000	$ 24,000	$ 56,000
16	Gross margin percentage ($32,000 ÷ $160,000; $24,000 ÷ $120,000; $56,000 ÷ $280,000)	20%	20%	20%

[5] Suppose Farmers' Dairy has beginning inventory of cream and liquid milk in May 2012 and when this inventory is sold, Farmers' earns a gross margin different from 20%. Then the gross-margin percentage for cream and liquid skim will not be the same. The relative gross-margin percentages will depend on how much of the sales of each product came from beginning inventory and how much came from current-period production.

power (their expected revenues). The cost-allocation base (total sales value at splitoff) is expressed in terms of a common denominator (the amount of revenues) that is systematically recorded in the accounting system. To use this method, selling prices must exist for all products at the splitoff point.

Physical-Measure Method

The **physical-measure method** allocates joint costs to joint products produced during the accounting period on the basis of a *comparable* physical measure, such as the relative weight, quantity, or volume at the splitoff point. In Example 1, the $400,000 joint costs produced 25,000 gallons of cream and 75,000 gallons of liquid skim. Using the number of gallons produced as the physical measure, Exhibit 16-4, Panel A, shows how joint costs are allocated to individual products to calculate the cost per gallon of cream and liquid skim.

Because the physical-measure method allocates joint costs on the basis of the number of gallons, cost per gallon is the same for both products. Exhibit 16-4, Panel B, presents the product-line income statement using the physical-measure method. The gross-margin percentages are 50% for cream and 0% for liquid skim.

Under the benefits-received criterion, the physical-measure method is much less desirable than the sales value at splitoff method, because the physical measure of the individual products may have no relationship to their respective revenue-generating abilities. Consider a gold mine that extracts ore containing gold, silver, and lead. Use of a common physical measure (tons) would result in almost all costs being allocated to lead, the product that weighs the most but has the lowest revenue-generating power. In the case of metals, the method of cost allocation is inconsistent with the main reason that the mining company is incurring mining costs—to earn revenues from gold and silver, not lead. When a company uses the physical-measure method in a product-line income statement, products that have a high sales value per ton, like gold and silver, would show a large "profit," and products that have a low sales value per ton, like lead, would show sizable losses.

Obtaining comparable physical measures for all products is not always straightforward. Consider the joint costs of producing oil and natural gas; oil is a liquid and gas is a vapor. To use a physical measure, the oil and gas need to be converted to the energy equivalent for oil and gas, British thermal units (BTUs). Using some physical measures to allocate joint costs may require assistance from technical personnel outside of accounting.

Determining which products of a joint process to include in a physical-measure computation can greatly affect the allocations to those products. Outputs with no sales value

Exhibit 16-4 Joint-Cost Allocation and Product-Line Income Statement Using Physical-Measure Method: Farmers' Dairy for May 2012

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	A	B	C	D
1	**PANEL A: Allocation of Joint Costs Using Physical-Measure Method**	**Cream**	**Liquid Skim**	**Total**
2	Physical measure of total production (gallons)	25,000	75,000	100,000
3	Weighting (25,000 gallons ÷ 100,000 gallons; 75,000 gallons ÷ 100,000 gallons)	0.25	0.75	
4	Joint costs allocated (0.25 × $400,000; 0.75 × $400,000)	$100,000	$300,000	$400,000
5	Joint production cost per gallon ($100,000 ÷ 25,000 gallons; $300,000 ÷ 75,000 gallons)	$ 4.00	$ 4.00	
6				
7	**PANEL B: Product-Line Income Statement Using Physical-Measure Method for May 2012**	**Cream**	**Liquid Skim**	**Total**
8	Revenues (20,000 gallons × $8 per gallon; 30,000 gallons × $4 per gallon)	$160,000	$120,000	$280,000
9	Cost of goods sold (joint costs)			
10	Production costs (0.25 × $400,000; 0.75 × $400,000)	100,000	300,000	400,000
11	Deduct ending inventory (5,000 gallons × $4 per gallon; 45,000 gallons × $4 per gallon)	20,000	180,000	200,000
12	Cost of goods sold (joint costs)	80,000	120,000	200,000
13	Gross margin	$ 80,000	$ 0	$ 80,000
14	Gross margin percentage ($80,000 ÷ $160,000; $0 ÷ $120,000; $80,000 ÷ $280,000)	50%	0%	28.6%

(such as dirt in gold mining) are always excluded. Although many more tons of dirt than gold are produced, costs are not incurred to produce outputs that have zero sales value. Byproducts are also often excluded from the denominator used in the physical-measure method because of their low sales values relative to the joint products or the main product. The general guideline for the physical-measure method is to include only the joint-product outputs in the weighting computations.

Net Realizable Value Method

In many cases, products are processed beyond the splitoff point to bring them to a marketable form or to increase their value above their selling price at the splitoff point. For example, when crude oil is refined, the gasoline, kerosene, benzene, and naphtha must be processed further before they can be sold. To illustrate, let's extend the Farmers' Dairy example.

Example 2: Assume the same data as in Example 1 except that both cream and liquid skim can be processed further:

- Cream → Buttercream: 25,000 gallons of cream are further processed to yield 20,000 gallons of buttercream at additional processing costs of $280,000. Buttercream, which sells for $25 per gallon, is used in the manufacture of butter-based products.
- Liquid Skim → Condensed Milk: 75,000 gallons of liquid skim are further processed to yield 50,000 gallons of condensed milk at additional processing costs of $520,000. Condensed milk sells for $22 per gallon.
- Sales during May 2012 are 12,000 gallons of buttercream and 45,000 gallons of condensed milk.

Exhibit 16-5, Panel A, depicts how (a) raw milk is converted into cream and liquid skim in the joint production process, and (b) how cream is separately processed into buttercream and liquid skim is separately processed into condensed milk. Panel B shows the data for Example 2.

The **net realizable value (NRV) method** allocates joint costs to joint products produced during the accounting period on the basis of their relative NRV—final sales value minus separable costs. The NRV method is typically used in preference to the sales value at splitoff method only when selling prices for one or more products at splitoff do not exist. Using this method for Example 2, Exhibit 16-6, Panel A, shows how joint costs are allocated to individual products to calculate cost per gallon of buttercream and condensed milk.

Exhibit 16-6, Panel B presents the product-line income statement using the NRV method. Gross-margin percentages are 22.0% for buttercream and 26.4% for condensed milk.

The NRV method is often implemented using simplifying assumptions. For example, even when selling prices of joint products vary frequently, companies implement the

PANEL A: Graphical Presentation of Process for Example 2

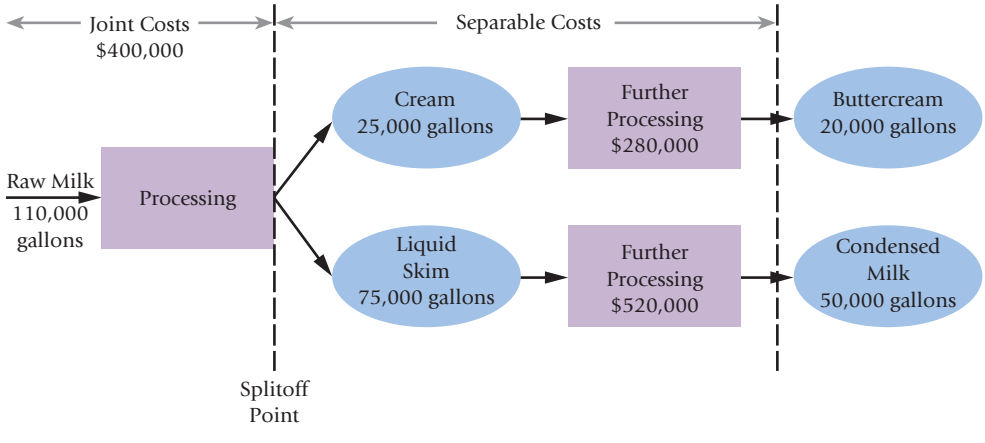


Exhibit 16-5

Example 2: Overview of Farmers' Dairy

Exhibit 16-5 Example 2: Overview of Farmers' Dairy (*continued*)

PANEL B: Data for Example 2

	A	B	C	D	E
1		**Joint Costs**		**Buttercream**	**Condensed Milk**
2	Joint costs (costs of 110,000 gallons raw milk and processing to splitoff point)	$400,000			
3	Separable cost of processing 25,000 gallons cream into 20,000 gallons buttercream			$280,000	
4	Separable cost of processing 75,000 gallons liquid skim into 50,000 gallons condensed milk				$520,000
5					
6		**Cream**	**Liquid Skim**	**Buttercream**	**Condensed Milk**
7	Beginning inventory (gallons)	0	0	0	0
8	Production (gallons)	25,000	75,000	20,000	50,000
9	Transfer for further processing (gallons)	25,000	75,000		
10	Sales (gallons)			12,000	45,000
11	Ending inventory (gallons)	0	0	8,000	5,000
12	Selling price per gallon	$ 8	$ 4	$ 25	$ 22

Exhibit 16-6 Joint-Cost Allocation and Product-Line Income Statement Using NRV Method: Farmers' Dairy for May 2012

	A	B	C	D
1	**PANEL A: Allocation of Joint Costs Using Net Realizable Value Method**	**Buttercream**	**Condensed Milk**	**Total**
2	Final sales value of total production during accounting period			
3	(20,000 gallons × $25 per gallon; 50,000 gallons × $22 per gallon)	$500,000	$1,100,000	$1,600,000
4	Deduct separable costs	280,000	520,000	800,000
5	Net realizable value at splitoff point	$220,000	$ 580,000	$ 800,000
6	Weighting ($220,000 ÷ $800,000; $580,000 ÷ $800,000)	0.275	0.725	
7	Joint costs allocated (0.275 × $400,000; 0.725 × $400,000)	$110,000	$ 290,000	$ 400,000
8	Production cost per gallon			
9	([$110,000 + $280,000] ÷ 20,000 gallons; [$290,000 + $520,000] ÷ 50,000 gallons)	$ 19.50	$ 16.20	
10				
11	**PANEL B: Product-Line Income Statement Using Net Realizable Value Method for May 2012**	**Buttercream**	**Condensed Milk**	**Total**
12	Revenues (12,000 gallons × $25 per gallon; 45,000 gallons × $22 per gallon)	$300,000	$ 990,000	$1,290,000
13	Cost of goods sold			
14	Joint costs (0.275 × $400,000; 0.725 × $400,000)	110,000	290,000	400,000
15	Separable costs	280,000	520,000	800,000
16	Production costs	390,000	810,000	1,200,000
17	Deduct ending inventory (8,000 gallons × $19.50 per gallon; 5,000 gallons × $16.20 per gallon)	156,000	81,000	237,000
18	Cost of goods sold	234,000	729,000	963,000
19	Gross margin	$ 66,000	$ 261,000	$ 327,000
20	Gross margin percentage ($66,000 ÷ $300,000; $261,000 ÷ $990,000; $327,000 ÷ $1,290,000)	22.0%	26.4%	25.3%

NRV method using a given set of selling prices throughout the accounting period. Similarly, even though companies may occasionally change the number or sequence of processing steps beyond the splitoff point in order to adjust to variations in input quality or local conditions, they assume a specific constant set of such steps when implementing the NRV method.

Constant Gross-Margin Percentage NRV Method

The **constant gross-margin percentage NRV method** allocates joint costs to joint products produced during the accounting period in such a way that each individual product achieves an identical gross-margin percentage. The method works backward in that the

overall gross margin is computed first. Then, for each product, this gross-margin percentage and any separable costs are deducted from the final sales value of production in order to back into the joint cost allocation for that product. The method can be broken down into three discrete steps. Exhibit 16-7, Panel A, shows these steps for allocating the $400,000 joint costs between buttercream and condensed milk in the Farmers' Dairy example. As we describe each step, refer to Exhibit 16-7, Panel A, for an illustration of the step.

Step 1: Compute overall gross margin percentage. The overall gross-margin percentage for all joint products together is calculated first. This is based on the final sales value of *total production* during the accounting period, not the *total revenues* of the period. Note, Exhibit 16-7, Panel A, uses $1,600,000, the final expected sales value of the entire output of buttercream and condensed milk, not the $1,290,000 in actual sales revenue for the month of May.

Step 2: Compute total production costs for each product. The gross margin (in dollars) for each product is computed by multiplying the overall gross-margin percentage by the product's final sales value of total production. The difference between the final sales value of total production and the gross margin then yields the total production costs that the product must bear.

Step 3: Compute allocated joint costs. As the final step, the separable costs for each product are deducted from the total production costs that the product must bear to obtain the joint-cost allocation for that product.

Exhibit 16-7, Panel B, presents the product-line income statement for the constant gross-margin percentage NRV method.

Exhibit 16-7 Joint-Cost Allocation and Product-Line Income Statement Using Constant Gross-Margin Percentage NRV Method: Farmers' Dairy for May 2012

	A	B	C	D
1	**PANEL A: Allocation of Joint Costs Using Constant Gross-Margin Percentage NRV Method**			
2	**Step 1**			
3	Final sales value of total production during accounting period: (20,000 gallons × $25 per gallon) + (50,000 gallons × $22 per gallon)	$1,600,000		
4	Deduct joint and separable costs ($400,000 + $280,000 + $520,000)	1,200,000		
5	Gross margin	$ 400,000		
6	Gross margin percentage ($400,000 ÷ $1,600,000)	25%		
7		**Buttercream**	**Condensed Milk**	**Total**
8	**Step 2**			
9	Final sales value of total production during accounting period: (20,000 gallons × $25 per gallon; 50,000 gallons × $22 per gallon)	$ 500,000	$1,100,000	$1,600,000
10	Deduct gross margin, using overall gross-margin percentage (25% × $500,000; 25% × $1,100,000)	125,000	275,000	400,000
11	Total production costs	375,000	825,000	1,200,000
12	**Step 3**			
13	Deduct separable costs	280,000	520,000	800,000
14	Joint costs allocated	$ 95,000	$ 305,000	$ 400,000
15				
16	**PANEL B: Product-Line Income Statement Using Constant Gross-Margin Percentage NRV Method for May 2012**	**Buttercream**	**Condensed Milk**	**Total**
17	Revenues (12,000 gallons × $25 per gallon; 45,000 gallons × $22 per gallon)	$ 300,000	$ 990,000	$1,290,000
18	Cost of goods sold			
19	Joint costs (from Panel A)	95,000	305,000	400,000
20	Separable costs	280,000	520,000	800,000
21	Production costs	375,000	825,000	1,200,000
22	Deduct ending inventory			
23	(8,000 gallons × $18.75 per gallon[a]; 5,000 gallons × $16.50 per gallon[b])	150,000	82,500	232,500
24	Cost of goods sold	225,000	742,500	967,500
25	Gross margin	$ 75,000	$ 247,500	$ 322,500
26	Gross margin percentage ($75,000 ÷ 300,000; $247,500 ÷ $990,000; $322,500 ÷ $1,290,000)	25%	25%	25%
27				
28	[a]Total production costs of buttercream ÷ Total production of buttercream = $375,000 ÷ 20,000 gallons = $18.75 per gallon.			
29	[b]Total production costs of condensed milk ÷ Total production of condensed milk = $825,000 ÷ 50,000 gallons = $16.50 per gallon.			

Decision Point

What methods can be used to allocate joint costs to individual products?

The constant gross-margin percentage NRV method is the only method of allocating joint costs under which products may receive negative allocations. This may be required in order to bring the gross-margin percentages of relatively unprofitable products up to the overall average. The constant gross-margin percentage NRV method also differs from the other two market-based joint-cost-allocation methods described earlier in another fundamental way. Neither the sales value at splitoff method nor the NRV method takes account of profits earned either before or after the splitoff point when allocating the joint costs. In contrast, the constant gross-margin percentage NRV method allocates both joint costs and profits: Gross margin is allocated to the joint products in order to determine the joint-cost allocations so that the resulting gross-margin percentage for each product is the same.

Choosing an Allocation Method

Learning Objective 4

Explain when the sales value at splitoff method is preferred when allocating joint costs

. . . because it objectively measures the benefits received by each product

Which method of allocating joint costs should be used? The sales value at splitoff method is preferable when selling-price data exist at splitoff (even if further processing is done). Reasons for using the sales value at splitoff method include the following:

1. **Measurement of the value of the joint products at the splitoff point.** Sales value at splitoff is the best measure of the benefits received as a result of joint processing relative to all other methods of allocating joint costs. It is a meaningful basis for allocating joint costs because generating revenues is the reason why a company incurs joint costs in the first place. It is also sometimes possible to vary the physical mix of final output and thereby produce more or less market value by incurring more joint costs. In such cases, there is a clear causal link between total cost and total output value, thereby further validating the use of the sales value at splitoff method.[6]
2. **No anticipation of subsequent management decisions.** The sales value at splitoff method does not require information on the processing steps after splitoff if there is further processing. In contrast, the NRV and constant gross-margin percentage NRV methods require information on (a) the specific sequence of further processing decisions, (b) the separable costs of further processing, and (c) the point at which individual products will be sold.
3. **Availability of a common basis to allocate joint costs to products.** The sales value at splitoff method (as well as other market-based methods) has a common basis to allocate joint costs to products, which is revenue. In contrast, the physical-measure at splitoff method may lack an easily identifiable common basis to allocate joint costs to individual products.
4. **Simplicity.** The sales value at splitoff method is simple. In contrast, the NRV and constant gross-margin percentage NRV methods can be complex for processing operations having multiple products and multiple splitoff points. This complexity increases when management makes frequent changes in the specific sequence of post-splitoff processing decisions or in the point at which individual products are sold.

When selling prices of all products at the splitoff point are unavailable, the NRV method is commonly used because it attempts to approximate sales value at splitoff by subtracting from selling prices separable costs incurred after the splitoff point. The NRV method assumes that all the markup or profit margin is attributable to the joint process and none of the markup is attributable to the separable costs. Profit, however, is attributable to all phases of production and marketing, not just the joint process. More of the profit may be attributable to the joint process if the separable process is relatively routine, whereas more of the profit may be attributable to the separable process if the separable process uses a special patented technology. Despite its complexities, the NRV method is used when selling prices at splitoff are not available as it provides a better measure of benefits received compared with the constant gross-margin percentage NRV method or the physical-measure method.

[6] In the semiconductor industry, for example, the use of cleaner facilities, higher quality silicon wafers, and more sophisticated equipment (all of which require higher joint costs) shifts the distribution of output to higher-quality memory devices with more market value. For details, see J. F. Gatti and D. J. Grinnell, "Joint Cost Allocations: Measuring and Promoting Productivity and Quality Improvements," *Journal of Cost Management* (2000). The authors also demonstrate that joint cost allocations based on market value are preferable for promoting quality and productivity improvements.

The constant gross-margin percentage NRV method makes the simplifying assumption of treating the joint products as though they comprise a single product. This method calculates the aggregate gross-margin percentage, applies this gross-margin percentage to each product, and views the residual after separable costs are accounted for as the implicit amount of joint costs assigned to each product. An advantage of this method is that it avoids the complexities inherent in the NRV method to measure the benefits received by each of the joint products at the splitoff point. The main issue with the constant gross-margin percentage NRV method is the assumption that all products have the same ratio of cost to sales value. Recall from our discussion of activity-based costing (ABC) in Chapter 5 that such a situation is very uncommon when companies offer a diverse set of products.

Although there are difficulties in using the physical-measure method—such as lack of congruence with the benefits-received criterion—there are instances when it may be preferred. Consider rate or price regulation. Market-based measures are difficult to use in this context because using selling prices as a basis for setting prices (rates) and at the same time using selling prices to allocate the costs on which prices (rates) are based leads to circular reasoning. To avoid this dilemma, the physical-measure method is useful in rate regulation.

Not Allocating Joint Costs

Some companies choose to not allocate joint costs to products. The usual rationale given by these firms is the complexity of their production or extraction processes and the difficulty of gathering sufficient data for carrying out the allocations correctly. For example, a recent survey of nine sawmills in Norway revealed that none of them allocated joint costs. The study's authors noted that the "interviewed sawmills considered the joint cost problem very interesting, but pointed out that the problem is not easily solved. For example, there is clearly a shortcoming in management systems designed for handling joint cost allocation."[7]

In the absence of joint cost allocation, some firms simply subtract the joint costs directly from total revenues in the management accounts. If substantial inventories exist, then firms that do not allocate joint costs often carry their product inventories at NRV. Industries that use variations of this approach include meatpacking, canning, and mining. Accountants do not ordinarily record inventories at NRV because this practice results in recognizing income on each product at the time production is completed and *before* sales are made. In response, some companies using this no-allocation approach carry their inventories at NRV minus an estimated operating income margin. When any end-of-period inventories are sold in the next period, the cost of goods sold then equals this carrying value. This approach is akin to the "production method" of accounting for byproducts, which we describe in detail later in this chapter.

Decision Point

When is the sales value at splitoff method considered preferable for allocating joint costs to individual products and why?

Irrelevance of Joint Costs for Decision Making

Chapter 11 introduced the concepts of *relevant revenues*, expected future revenues that differ among alternative courses of action, and *relevant costs*, expected future costs that differ among alternative courses of action. These concepts can be applied to decisions on whether a joint product or main product should be sold at the splitoff point or processed further.

Learning Objective 5

Explain why joint costs are irrelevant in a sell-or-process-further decision

. . . because joint costs are the same whether or not further processing occurs

Sell-or-Process-Further Decisions

Consider Farmers' Dairy's decision to either sell the joint products, cream and liquid skim, at the splitoff point or to further process them into buttercream and condensed milk. The decision to incur additional costs for further processing should be based on the incremental operating income attainable beyond the splitoff point. Example 2 assumed it was profitable for both cream and liquid skim to be further processed into buttercream

[7] For further details, see T. Tunes, A. Nyrud, and B. Eikenes, "Cost and Performance Management in the Sawmill Industry," *Scandinavian Forest Economics* (2006).

and condensed milk, respectively. The incremental analysis for the decision to process further is as follows:

Further Processing Cream into Buttercream	
Incremental revenues	
($25/gallon × 20,000 gallons) − ($8/gallon × 25,000 gallons)	$300,000
Deduct incremental processing costs	280,000
Increase in operating income from buttercream	$ 20,000
Further Processing Liquid Skim into Condensed Milk	
Incremental revenues	
($22/gallon × 50,000 gallons) − ($4/gallon × 75,000 gallons)	$800,000
Deduct incremental processing costs	520,000
Increase in operating income from condensed milk	$280,000

In this example, operating income increases for both products, so the manager decides to process cream into buttercream and liquid skim into condensed milk. *The $400,000 joint costs incurred before the splitoff point are irrelevant in deciding whether to process further.* Why? Because the joint costs of $400,000 are the same whether the products are sold at the splitoff point or processed further.

Incremental costs are the additional costs incurred for an activity, such as further processing. *Do not assume all separable costs in joint-cost allocations are always incremental costs.* Some separable costs may be fixed costs, such as lease costs on buildings where the further processing is done; some separable costs may be sunk costs, such as depreciation on the equipment that converts cream into buttercream; and some separable costs may be allocated costs, such as corporate costs allocated to the condensed milk operations. None of these costs will differ between the alternatives of selling products at the splitoff point or processing further; therefore, they are irrelevant.

Joint-Cost Allocation and Performance Evaluation

The potential conflict between cost concepts used for decision making and cost concepts used for evaluating the performance of managers could also arise in sell-or-process-further decisions. To see how, let us continue with Example 2. Suppose *allocated* fixed corporate and administrative costs of further processing cream into buttercream equal $30,000 and that these costs will be allocated only to buttercream and to the manager's product-line income statement if buttercream is produced. How might this policy affect the decision to process further?

As we have seen, on the basis of incremental revenues and incremental costs, Farmers' operating income will increase by $20,000 if it processes cream into buttercream. However, producing the buttercream also results in an additional charge for allocated fixed costs of $30,000. If the manager is evaluated on a full-cost basis (that is, after allocating all costs), processing cream into buttercream will lower the manager's performance-evaluation measure by $10,000 (incremental operating income, $20,000 − allocated fixed costs, $30,000). Therefore, the manager may be tempted to sell cream at splitoff and not process it into buttercream.

A similar conflict can also arise with respect to production of joint products. Consider again Example 1. Suppose Farmers' Dairy has the option of selling raw milk at a profit of $20,000. From a decision-making standpoint, Farmers' would maximize operating income by processing raw milk into cream and liquid skim because the total revenues from selling both joint products ($500,000, see Exhibit 16-3, p. 581) exceed the joint costs ($400,000, p. 580) by $100,000. (This amount is greater than the $20,000 Farmers' Dairy would make if it sold the raw milk instead of processing it.) Suppose, however, the cream and liquid-skim product lines are managed by different managers, each of whom is evaluated based on a product-line income statement. If the physical-measure method of joint-cost allocation is used and the selling price per gallon of liquid skim falls below $4.00 per gallon, the liquid-skim product line will show a loss (from Exhibit 16-4, p. 582, revenues will be less than $120,000, but cost of goods sold will be unchanged at $120,000). The manager of the liquid-skim line will prefer, from his or her performance-evaluation standpoint, to not produce liquid skim but rather to sell the raw milk.

This conflict between decision making and performance evaluation is less severe if Farmers' Dairy uses any of the market-based methods of joint-cost allocations—sales value at splitoff, NRV, or constant gross-margin percentage NRV—because each of these methods allocates costs using revenues, which generally leads to a positive income for each joint product.

Pricing Decisions

Decision Point

Are joint costs relevant in a sell-or-process-further decision?

Firms should be wary of using the full cost of a joint product (that is, the cost after joint costs are allocated) as the basis for making pricing decisions. Why? Because in many situations, there is no direct cause-and-effect relationship that identifies the resources demanded by each joint product that can then be used as a basis for pricing. In fact, the use of the sales value at splitoff or the net realizable value method to allocate joint costs results in a reverse effect—selling prices of joint products drive joint-cost allocations, rather than cost allocations serving as the basis for the pricing of joint products! Of course, the principles of pricing covered in Chapter 12 apply to the joint process taken as a whole. Even if the firm cannot alter the mix of products generated by the joint process, it must ensure that the joint products generate sufficient combined revenue in the long run to cover the joint costs of processing.

Accounting for Byproducts

Learning Objective 6

Account for byproducts using two methods

. . . recognize in financial statements at time of production or at time of sale

Joint production processes may yield not only joint products and main products but also byproducts. Although byproducts have relatively low total sales values, the presence of byproducts in a joint production process can affect the allocation of joint costs. Let's consider a two-product example consisting of a main product and a byproduct (also see the Concepts in Action feature on p. 590).

Example 3: The Westlake Corporation processes timber into fine-grade lumber and wood chips that are used as mulch in gardens and lawns. Information about these products follows:

- Fine-Grade lumber (the main product)—sells for $6 per board foot (b.f.)
- Wood chips (the byproduct)—sells for $1 per cubic foot (c.f.)

Data for July 2012 are as follows:

	Beginning Inventory	Production	Sales	Ending Inventory
Fine-Grade lumber (b.f.)	0	50,000	40,000	10,000
Wood chips (c.f.)	0	4,000	1,200	2,800

Joint manufacturing costs for these products in July 2012 are $250,000, comprising $150,000 for direct materials and $100,000 for conversion costs. Both products are sold at the splitoff point without further processing, as Exhibit 16-8 shows.

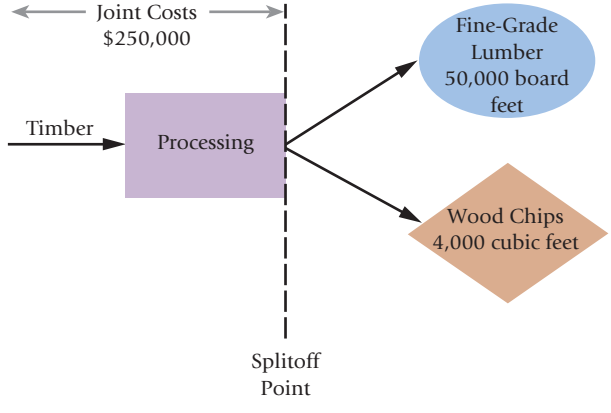


Exhibit 16-8

Example 3: Overview of Westlake Corporation

Concepts in Action

Byproduct Costing Keeps Wendy's Chili Profitable . . . and on the Menu

There are many examples in which joint and byproduct costing issues arise, including coal mining, semiconductor manufacturing, and Wendy's chili. You may be asking yourself, "chili from Wendy's?" Yes! The primary ingredient in chili at Wendy's, one of the largest fast-food chains in the United States, is a byproduct of overcooked, unsellable hamburger patties.

The most important product that Wendy's offers its customers is an "old-fashioned" hamburger, which is a hamburger served from the grill in accordance with individual customer orders. Operationally, the only way to serve hamburgers this way is to anticipate customer demand and have a sufficient supply of hamburgers already cooking when the customers arrive at the restaurant. The problem with this approach, however, is the fate of the extra hamburgers that become too well done whenever the cooks overestimate customer demand. Throwing them away would be too costly and wasteful, but serving them as "old-fashioned" hamburgers would likely result in considerable customer dissatisfaction.

For Wendy's, the solution to this dilemma involved finding a product that was unique to the fast-food industry and required ground beef as one of the major ingredients. Thus, Wendy's "rich and meaty" chili became one of its original menu items. For each batch of chili, which is prepared daily in each restaurant, Wendy's needs 48 quarter-pound cooked ground-beef patties along with crushed tomatoes, tomato juice, red beans, and seasoning. Only 10% of the time is it necessary for Wendy's to cook meat specifically for use in making chili.

Several years ago, Wendy's management considered eliminating some of its traditional menu items. Chili, composing only about 5% of total restaurant sales, was targeted for possible elimination, and at $0.99 for an eight-ounce serving, it brought in far less revenue than a product like a single hamburger, which sold for $1.89. When Wendy's compared the cost of making chili to its sale price, however, the product remained on the menu. How? The beef in Wendy's chili recipe was a byproduct of hamburger patties, its main product, which affected the allocation of joint costs.

Excluding ground beef, the costs to produce Wendy's chili are around $0.37 per eight-ounce serving, which includes labor. When Wendy's has to cook meat for its chili, again only 10% of the time, the recipe calls for ground beef that costs around $0.73 per serving. Under those circumstances, the chili costs Wendy's $1.10 to make, and each $.99 serving sells at a $0.11 loss. However, the 90% of the time Wendy's uses precooked ground beef for its chili, most of those costs have already been allocated to hamburgers, the primary product. As a result, each eight-ounce serving of chili Wendy's sells using precooked ground beef is sold at a significant profit. With a lucrative profit margin for each serving sold, customers are likely to find chili on the Wendy's menu for a long time to come.

Source: Brownlee, E. Richard. 2005. Wendy's chili: A costing conundrum. The University of Virginia Darden School of Business Case No. UVA-C-2206. Charlottesville, VA: Darden Business Publishing.

We present two byproduct accounting methods: the production method and the sales method. The production method recognizes byproducts in the financial statements at the time production is completed. The sales method delays recognition of byproducts until the time of sale.[8] Exhibit 16-9 presents the income statement of Westlake Corporation under both methods.

[8] For a discussion of joint cost allocation and byproduct accounting methods, see P. D. Marshall and R. F. Dombrowski, "A Small Business Review of Accounting for Primary Products, Byproducts and Scrap," *The National Public Accountant* (February/March 2003): 10–13.

Exhibit 16-9

Income Statements of Westlake Corporation for July 2012 Using the Production and Sales Methods for Byproduct Accounting

	Production Method	Sales Method
Revenues		
Main product: Fine-grade lumber (40,000 b.f. × $6 per b.f.)	$240,000	$240,000
Byproduct: Wood chips (1,200 c.f. × $1 per c.f.)	—	1,200
Total revenues	240,000	241,200
Cost of goods sold		
Total manufacturing costs	250,000	250,000
Deduct byproduct revenue (4,000 c.f. × $1 per c.f.)	(4,000)	—
Net manufacturing costs	246,000	250,000
Deduct main-product inventory	(49,200)[a]	(50,000)[b]
Cost of goods sold	196,800	200,000
Gross margin	$ 43,200	$ 41,200
Gross-margin percentage ($43,200 ÷ $240,000; $41,200 ÷ $241,200)	18.00%	17.08%
Inventoriable costs (end of period):		
Main product: Fine-grade lumber	$ 49,200	$ 50,000
Byproduct: Wood chips (2,800 c.f. × $1 per c.f.)[c]	2,800	0

[a](10,000 ÷ 50,000) × net manufacturing cost = (10,000 ÷ 50,000) × $246,000 = $49,200.

[b](10,000 ÷ 50,000) × total manufacturing cost = (10,000 ÷ 50,000) × $250,000 = $50,000.

[c]Recorded at selling prices.

Production Method: Byproducts Recognized at Time Production Is Completed

This method recognizes the byproduct in the financial statements—the 4,000 cubic feet of wood chips—in the month it is produced, July 2012. The NRV from the byproduct produced is offset against the costs of the main product. The following journal entries illustrate the production method:

1.	Work in Process	150,000	
	Accounts Payable		150,000
	To record direct materials purchased and used in production during July.		
2.	Work in Process	100,000	
	Various accounts such as Wages Payable and Accumulated Depreciation		100,000
	To record conversion costs in the production process during July; examples include energy, manufacturing supplies, all manufacturing labor, and plant depreciation.		
3.	Byproduct Inventory—Wood Chips (4,000 c.f. × $1 per c.f.)	4,000	
	Finished Goods—Fine-Grade Lumber ($250,000 − $4,000)	246,000	
	Work in Process ($150,000 + $100,000)		250,000
	To record cost of goods completed during July.		
4a.	Cost of Goods Sold [(40,000 b.f. ÷ 50,000 b.f.) × $246,000]	196,800	
	Finished Goods—Fine-Grade Lumber		196,800
	To record the cost of the main product sold during July.		
4b.	Cash or Accounts Receivable (40,000 b.f. × $6 per b.f.)	240,000	
	Revenues—Fine-Grade Lumber		240,000
	To record the sales of the main product during July.		
5.	Cash or Accounts Receivable (1,200 c.f. × $1 per c.f.)	1,200	
	Byproduct Inventory—Wood Chips		1,200
	To record the sales of the byproduct during July.		

The production method reports the byproduct inventory of wood chips in the balance sheet at its $1 per cubic foot selling price [(4,000 cubic feet − 1,200 cubic feet) × $1 per cubic foot = $2,800].

One variation of this method would be to report byproduct inventory at its NRV reduced by a normal profit margin ($2,800 − 20% × $2,800 = $2,240, assuming a

normal profit margin of 20%).[9] When byproduct inventory is sold in a subsequent period, the income statement will match the selling price, $2,800, with the "cost" reported for the byproduct inventory, $2,240, resulting in a byproduct operating income of $560 ($2,800 − $2,240).

Sales Method: Byproducts Recognized at Time of Sale

This method makes no journal entries for byproducts until they are sold. Revenues of the byproduct are reported as a revenue item in the income statement at the time of sale. These revenues are either grouped with other sales, included as other income, or are deducted from cost of goods sold. In the Westlake Corporation example, byproduct revenues in July 2012 are $1,200 (1,200 cubic feet × $1 per cubic foot) because only 1,200 cubic feet of wood chips are sold in July (of the 4,000 cubic feet produced). The journal entries are as follows:

1. and 2.	*Same as for the production method.*		
	Work in Process	150,000	
	Accounts Payable		150,000
	Work in Process	100,000	
	Various accounts such as Wages Payable and Accumulated Depreciation		100,000
3.	Finished Goods—Fine-Grade Lumber	250,000	
	Work in Process		250,000
	To record cost of main product completed during July.		
4a.	Cost of Goods Sold [(40,000 b.f. ÷ 50,000 b.f.) × $250,000]	200,000	
	Finished Goods—Fine-Grade Lumber		200,000
	To record the cost of the main product sold during July.		
4b.	Same as for the production method.		
	Cash or Accounts Receivable (40,000 b.f. × $6 per b.f.)	240,000	
	Revenues—Fine-Grade Lumber		240,000
5.	Cash or Accounts Receivable	1,200	
	Revenues—Wood Chips		1,200
	To record the sales of the byproduct during July.		

Decision Point

What methods can be used to account for byproducts and which of them is preferable?

Which method should a company use? The production method is conceptually correct in that it is consistent with the matching principle. This method recognizes byproduct inventory in the accounting period in which it is produced and simultaneously reduces the cost of manufacturing the main or joint products, thereby better matching the revenues and expenses from selling the main product. However, the sales method is simpler and is often used in practice, primarily on the grounds that the dollar amounts of byproducts are immaterial. Then again, the sales method permits managers to "manage" reported earnings by timing when they sell byproducts. Managers may store byproducts for several periods and give revenues and income a "small boost" by selling byproducts accumulated over several periods when revenues and profits from the main product or joint products are low.

Problem for Self-Study

Inorganic Chemicals (IC) processes salt into various industrial products. In July 2012, IC incurred joint costs of $100,000 to purchase salt and convert it into two products: caustic soda and chlorine. Although there is an active outside market for chlorine, IC processes all 800 tons of chlorine it produces into 500 tons of PVC (polyvinyl chloride), which is

[9] One way to make this calculation is to assume all products have the same "normal" profit margin like the constant gross-margin percentage NRV method. Alternatively, the company might allow products to have different profit margins based on an analysis of the margins earned by other companies that sell these products individually.

then sold. There were no beginning or ending inventories of salt, caustic soda, chlorine, or PVC in July. Information for July 2012 production and sales follows:

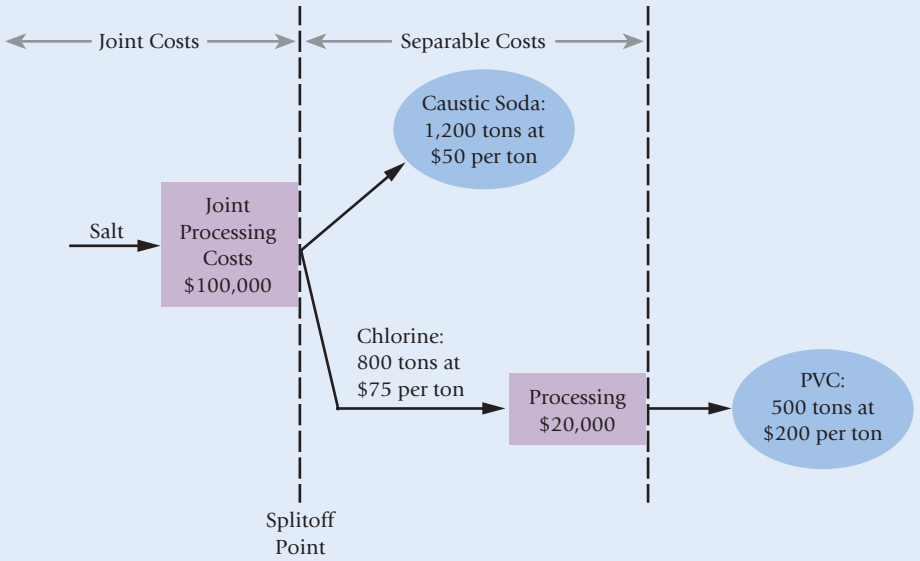
	A	B	C	D
1		**Joint Costs**		**PVC**
2	Joint costs (costs of salt and processing to splitoff point)	$100,000		
3	Separable cost of processing 800 tons chlorine into 500 tons PVC			$20,000
4				
5		**Caustic Soda**	**Chlorine**	**PVC**
6	Beginning inventory (tons)	0	0	0
7	Production (tons)	1,200	800	500
8	Transfer for further processing (tons)		800	
9	Sales (tons)	1,200		500
10	Ending inventory (tons)	0	0	0
11	Selling price per ton in active outside market (for products not actually sold)		$ 75	
12	Selling price per ton for products sold	$ 50		$ 200

Required

1. Allocate the joint costs of $100,000 between caustic soda and PVC under (a) the sales value at splitoff method and (b) the physical-measure method.
2. Allocate the joint costs of $100,000 between caustic soda and PVC under the NRV method.
3. Under the three allocation methods in requirements 1 and 2, what is the gross-margin percentage of (a) caustic soda and (b) PVC?
4. Lifetime Swimming Pool Products offers to purchase 800 tons of chlorine in August 2012 at $75 per ton. Assume all other production and sales data are the same for August as they were for July. This sale of chlorine to Lifetime would mean that no PVC would be produced by IC in August. How would accepting this offer affect IC's August 2012 operating income?

Solution

The following picture provides a visual illustration of the main facts in this problem.



Note that caustic soda is sold as is while chlorine, despite having a market value at splitoff, is sold only in processed form as PVC. The goal is to allocate the joint costs of $100,000 to the final products—caustic soda and PVC. However, since PVC exists only in the form of chlorine at the splitoff point, we use chlorine's sales value and physical measure as the basis for allocating joint costs to PVC under the sales value at splitoff and physical measure at splitoff methods. Detailed calculations are shown next.

1a. Sales value at splitoff method

	A	B	C	D
1	**Allocation of Joint Costs Using Sales Value at Splitoff Method**	**Caustic Soda**	**PVC / Chlorine**	**Total**
2	Sales value of total production at splitoff point			
3	(1,200 tons × $50 per ton; 800 × $75 per ton)	$60,000	$60,000	$120,000
4	Weighting ($60,000 ÷ $120,000; $60,000 ÷ $120,000)	0.50	0.50	
5	Joint costs allocated (0.50 × $100,000; 0.50 × $100,000)	$50,000	$50,000	$100,000

1b. Physical-measure method

	A	B	C	D
8	**Allocation of Joint Costs Using Physical-Measure Method**	**Caustic Soda**	**PVC / Chlorine**	**Total**
9	Physical measure of total production (tons)	1,200	800	2,000
10	Weighting (1,200 tons ÷ 2,000 tons; 800 tons ÷ 2,000 tons)	0.60	0.40	
11	Joint cost allocated (0.60 × $100,000; 0.40 × $100,000)	$60,000	$40,000	$100,000

2. Net realizable value (NRV) method

	A	B	C	D
14	**Allocation of Joint Costs Using Net Realizable Value Method**	**Caustic Soda**	**PVC**	**Total**
15	Final sales value of total production during accounting period			
16	(1,200 tons × $50 per ton; 500 tons × $200 per ton)	$60,000	$100,000	$160,000
17	Deduct separable costs to complete and sell	0	20,000	20,000
18	Net realizable value at splitoff point	$60,000	$ 80,000	$140,000
19	Weighting ($60,000 ÷ $140,000; $80,000 ÷ $140,000)	3/7	4/7	
20	Joint costs allocated (3/7 × $100,000; 4/7 × $100,000)	$42,857	$ 57,143	$100,000

3a. Gross-margin percentage of caustic soda

	A	B	C	D
23	**Caustic Soda**	**Sales Value at Splitoff Point**	**Physical Measure**	**NRV**
24	Revenues (1,200 tons × $50 per ton)	$60,000	$60,000	$60,000
25	Cost of goods sold (joint costs)	50,000	60,000	42,857
26	Gross margin	$10,000	$ 0	$17,143
27	Gross margin percentage ($10,000 ÷ $60,000; $0 ÷ $60,000; $17,143 ÷ $60,000)	16.67%	0.00%	28.57%

3b. Gross-margin percentage of PVC

	A	B	C	D
30	PVC	Sales Value at Splitoff Point	Physical Measure	NRV
31	Revenues (500 tons × $200 per ton)	$100,000	$100,000	$100,000
32	Cost of goods sold			
33	Joint costs	50,000	40,000	57,143
34	Separable costs	20,000	20,000	20,000
35	Cost of goods sold	70,000	60,000	77,143
36	Gross margin	$ 30,000	$ 40,000	$ 22,857
37	Gross margin percentage ($30,000 ÷ $100,000; $40,000 ÷ $100,000; $22,857 ÷ $100,000)	30.00%	40.00%	22.86%

4. Sale of chlorine versus processing into PVC

	A	B
40	Incremental revenue from processing 800 tons of chlorine into 500 tons of PVC	
41	(500 tons × $200 per ton) – (800 tons × $75 per ton)	$40,000
42	Incremental cost of processing 800 tons of chlorine into 500 tons of PVC	20,000
43	Incremental operating income from further processing	$20,000

If IC sells 800 tons of chlorine to Lifetime Swimming Pool Products instead of further processing it into PVC, its August 2012 operating income will be reduced by $20,000.

Decision Points

The following question-and-answer format summarizes the chapter's learning objectives. Each decision presents a key question related to a learning objective. The guidelines are the answer to that question.

Decision	Guidelines
1. What do the terms joint cost and splitoff point mean, and how do joint products differ from byproducts?	A joint cost is the cost of a single production process that yields multiple products simultaneously. The splitoff point is the juncture in a joint production process when the products become separately identifiable. Joint products have high total sales values at the splitoff point. A byproduct has a low total sales value at the splitoff point compared with the total sales value of a joint or main product.
2. Why are joint costs allocated to individual products?	The purposes for allocating joint costs to products include inventory costing for financial accounting and internal reporting, cost reimbursement, insurance settlements, rate regulation, and product-cost litigation.
3. What methods can be used to allocate joint costs to individual products?	The methods to allocate joint costs to products are the sales value at splitoff, NRV, constant gross-margin percentage NRV, and physical-measure methods.

4. When is the sales value at splitoff method considered preferable for allocating joint costs to individual products and why?	The sales value at splitoff method is preferable when market prices exist at splitoff because using revenues is consistent with the benefits-received criterion; further, the method does not anticipate subsequent management decisions on further processing, and is simple.
5. Are joint costs relevant in a sell-or-process-further decision?	No, joint costs and how they are allocated are irrelevant in deciding whether to process further because joint costs are the same regardless of whether further processing occurs.
6. What methods can be used to account for byproducts and which of them is preferable?	The production method recognizes byproducts in financial statements at the time of production, whereas the sales method recognizes byproducts in financial statements at the time of sale. The production method is conceptually superior, but the sales method is often used in practice because dollar amounts of byproducts are immaterial.

Terms to Learn

This chapter and the Glossary at the end of the book contain definitions of the following important terms:

byproducts **(p. 578)**
constant gross-margin percentage NRV method **(p. 584)**
joint costs **(p. 577)**
joint products **(p. 578)**
main product **(p. 578)**
net realizable value (NRV) method **(p. 583)**
physical-measure method **(p. 582)**
product **(p. 578)**
sales value at splitoff method **(p. 580)**
separable costs **(p. 577)**
splitoff point **(p. 577)**

Assignment Material

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Questions

16-1 Give two examples of industries in which joint costs are found. For each example, what are the individual products at the splitoff point?
16-2 What is a joint cost? What is a separable cost?
16-3 Distinguish between a joint product and a byproduct.
16-4 Why might the number of products in a joint-cost situation differ from the number of outputs? Give an example.
16-5 Provide three reasons for allocating joint costs to individual products or services.
16-6 Why does the sales value at splitoff method use the sales value of the total production in the accounting period and not just the revenues from the products sold?
16-7 Describe a situation in which the sales value at splitoff method cannot be used but the NRV method can be used for joint-cost allocation.
16-8 Distinguish between the sales value at splitoff method and the NRV method.
16-9 Give two limitations of the physical-measure method of joint-cost allocation.
16-10 How might a company simplify its use of the NRV method when final selling prices can vary sizably in an accounting period and management frequently changes the point at which it sells individual products?
16-11 Why is the constant gross-margin percentage NRV method sometimes called a "joint-cost-allocation and a profit-allocation" method?
16-12 "Managers must decide whether a product should be sold at splitoff or processed further. The sales value at splitoff method of joint-cost allocation is the best method for generating the information managers need for this decision." Do you agree? Explain.
16-13 "Managers should consider only additional revenues and separable costs when making decisions about selling at splitoff or processing further." Do you agree? Explain.
16-14 Describe two major methods to account for byproducts.
16-15 Why might managers seeking a monthly bonus based on attaining a target operating income prefer the sales method of accounting for byproducts rather than the production method?

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Exercises

16-16 Joint-cost allocation, insurance settlement. Quality Chicken grows and processes chickens. Each chicken is disassembled into five main parts. Information pertaining to production in July 2012 is as follows:

Parts	Pounds of Product	Wholesale Selling Price per Pound When Production Is Complete
Breasts	100	$0.55
Wings	20	0.20
Thighs	40	0.35
Bones	80	0.10
Feathers	10	0.05

Joint cost of production in July 2012 was $50.

A special shipment of 40 pounds of breasts and 15 pounds of wings has been destroyed in a fire. Quality Chicken's insurance policy provides reimbursement for the cost of the items destroyed. The insurance company permits Quality Chicken to use a joint-cost-allocation method. The splitoff point is assumed to be at the end of the production process.

Required

1. Compute the cost of the special shipment destroyed using the following:
   a. Sales value at splitoff method
   b. Physical-measure method (pounds of finished product)
2. What joint-cost-allocation method would you recommend Quality Chicken use? Explain.

16-17 Joint products and byproducts (continuation of 16-16). Quality Chicken is computing the ending inventory values for its July 31, 2012, balance sheet. Ending inventory amounts on July 31 are 15 pounds of breasts, 4 pounds of wings, 6 pounds of thighs, 5 pounds of bones, and 2 pounds of feathers.

Quality Chicken's management wants to use the sales value at splitoff method. However, management wants you to explore the effect on ending inventory values of classifying one or more products as a byproduct rather than a joint product.

Required

1. Assume Quality Chicken classifies all five products as joint products. What are the ending inventory values of each product on July 31, 2012?
2. Assume Quality Chicken uses the production method of accounting for byproducts. What are the ending inventory values for each joint product on July 31, 2012, assuming breasts and thighs are the joint products and wings, bones, and feathers are byproducts?
3. Comment on differences in the results in requirements 1 and 2.

16-18 Net realizable value method. Convad Company is one of the world's leading corn refiners. It produces two joint products—corn syrup and corn starch—using a common production process. In July 2012, Convad reported the following production and selling-price information:

	A	B	C	D
1		Corn Syrup	Corn Starch	Joint Costs
2	Joint costs (costs of processing corn to splitoff point)			$325,000
3	Separable cost of processing beyond splitoff point	$375,000	$93,750	
4	Beginning inventory (cases)	0	0	
5	Production and Sales (cases)	12,500	6,250	
6	Ending inventory (cases)	0	0	
7	Selling price per case	50	$ 25	

Allocate the $325,000 joint costs using the NRV method.

Required

16-19 Alternative joint-cost-allocation methods, further-process decision. The Wood Spirits Company produces two products—turpentine and methanol (wood alcohol)—by a joint process. Joint costs amount to $120,000 per batch of output. Each batch totals 10,000 gallons: 25% methanol and 75% turpentine. Both products are processed further without gain or loss in volume. Separable processing costs are methanol, $3 per gallon; turpentine, $2 per gallon. Methanol sells for $21 per gallon. Turpentine sells for $14 per gallon.

Required

1. How much of the joint costs per batch will be allocated to turpentine and to methanol, assuming that joint costs are allocated based on the number of gallons at splitoff point?
2. If joint costs are allocated on an NRV basis, how much of the joint costs will be allocated to turpentine and to methanol?
3. Prepare product-line income statements per batch for requirements 1 and 2. Assume no beginning or ending inventories.
4. The company has discovered an additional process by which the methanol (wood alcohol) can be made into a pleasant-tasting alcoholic beverage. The selling price of this beverage would be $60 a gallon. Additional processing would increase separable costs $9 per gallon (in addition to the $3 per gallon separable cost

required to yield methanol). The company would have to pay excise taxes of 20% on the selling price of the beverage. Assuming no other changes in cost, what is the joint cost applicable to the wood alcohol (using the NRV method)? Should the company produce the alcoholic beverage? Show your computations.

16-20 Alternative methods of joint-cost allocation, ending inventories. The Evrett Company operates a simple chemical process to convert a single material into three separate items, referred to here as X, Y, and Z. All three end products are separated simultaneously at a single splitoff point.

Products X and Y are ready for sale immediately upon splitoff without further processing or any other additional costs. Product Z, however, is processed further before being sold. There is no available market price for Z at the splitoff point.

The selling prices quoted here are expected to remain the same in the coming year. During 2012, the selling prices of the items and the total amounts sold were as follows:

- X—75 tons sold for $1,800 per ton
- Y—225 tons sold for $1,300 per ton
- Z—280 tons sold for $800 per ton

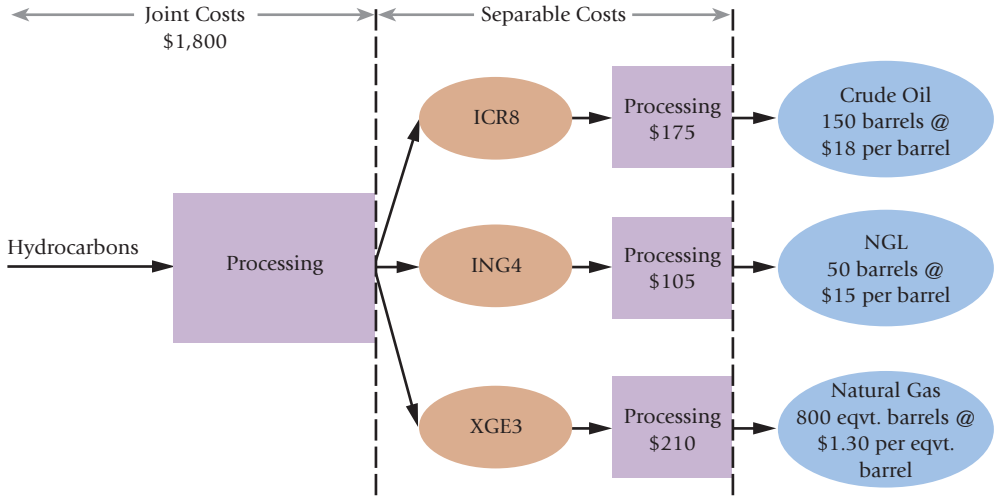
The total joint manufacturing costs for the year were $328,000. Evrett spent an additional $120,000 to finish product Z.

There were no beginning inventories of X, Y, or Z. At the end of the year, the following inventories of completed units were on hand: X, 175 tons; Y, 75 tons; Z, 70 tons. There was no beginning or ending work in process.

Required

1. Compute the cost of inventories of X, Y, and Z for balance sheet purposes and the cost of goods sold for income statement purposes as of December 31, 2012, using the following joint cost allocation methods:
   a. NRV method
   b. Constant gross-margin percentage NRV method
2. Compare the gross-margin percentages for X, Y, and Z using the two methods given in requirement 1.

16-21 Joint-cost allocation, process further. Sinclair Oil & Gas, a large energy conglomerate, jointly processes purchased hydrocarbons to generate three nonsaleable intermediate products: ICR8, ING4, and XGE3. These intermediate products are further processed separately to produce crude oil, natural gas liquids (NGL), and natural gas (measured in liquid equivalents). An overview of the process and results for August 2012 are shown here. (Note: The numbers are small to keep the focus on key concepts.)

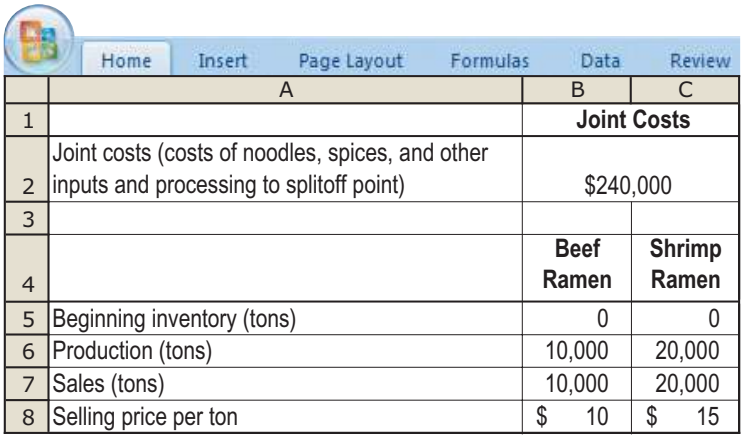


A new federal law has recently been passed that taxes crude oil at 30% of operating income. No new tax is to be paid on natural gas liquid or natural gas. Starting August 2012, Sinclair Oil & Gas must report a separate product-line income statement for crude oil. One challenge facing Sinclair Oil & Gas is how to allocate the joint cost of producing the three separate saleable outputs. Assume no beginning or ending inventory.

Required

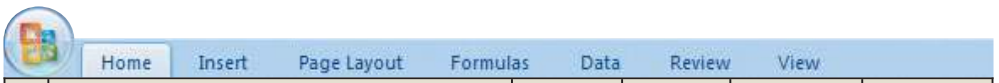
1. Allocate the August 2012 joint cost among the three products using the following:
   a. Physical-measure method
   b. NRV method
2. Show the operating income for each product using the methods in requirement 1.
3. Discuss the pros and cons of the two methods to Sinclair Oil & Gas for making decisions about product emphasis (pricing, sell-or-process-further decisions, and so on).
4. Draft a letter to the taxation authorities on behalf of Sinclair Oil & Gas that justifies the joint-cost-allocation method you recommend Sinclair use.

16-22 Joint-cost allocation, sales value, physical measure, NRV methods. Instant Foods produces two types of microwavable products—beef-flavored ramen and shrimp-flavored ramen. The two products share common inputs such as noodle and spices. The production of ramen results in a waste product referred to as stock, which Instant dumps at negligible costs in a local drainage area. In June 2012, the following data were reported for the production and sales of beef-flavored and shrimp-flavored ramen:



	A	B	C
1		**Joint Costs**	
2	Joint costs (costs of noodles, spices, and other inputs and processing to splitoff point)	$240,000	
3			
4		**Beef Ramen**	**Shrimp Ramen**
5	Beginning inventory (tons)	0	0
6	Production (tons)	10,000	20,000
7	Sales (tons)	10,000	20,000
8	Selling price per ton	$ 10	$ 15

Due to the popularity of its microwavable products, Instant decides to add a new line of products that targets dieters. These new products are produced by adding a special ingredient to dilute the original ramen and are to be sold under the names Special B and Special S, respectively. The following is the monthly data for all the products:



	A	B	C	D	E
11		**Joint Costs**		**Special B**	**Special S**
12	Joint costs (costs of noodles, spices, and other inputs and processing to splitoff point)	$240,000			
13	Separable costs of processing 10,000 tons of Beef Ramen into 12,000 tons of Special B			$48,000	
14	Separable cost of processing 20,000 tons of Shrimp Ramen into 24,000 tons of Special S				$168,000
15					
16		**Beef Ramen**	**Shrimp Ramen**	**Special B**	**Special S**
17	Beginning inventory (tons)	0	0	0	0
18	Production (tons)	10,000	20,000	12,000	24,000
19	Transfer for further processing (tons)	10,000	20,000		
20	Sales (tons)			12,000	24,000
21	Selling price per ton	$ 10	$ 15	$ 18	$ 25

Required

1. Calculate Instant's gross-margin percentage for Special B and Special S when joint costs are allocated using the following:
   a. Sales value at splitoff method
   b. Physical-measure method
   c. Net realizable value method
2. Recently, Instant discovered that the stock it is dumping can be sold to cattle ranchers at $5 per ton. In a typical month with the production levels shown, 4,000 tons of stock are produced and can be sold by incurring marketing costs of $10,800. Sherrie Dong, a management accountant, points out that treating the stock as a joint product and using the sales value at splitoff method, the stock product would lose about $2,228 each month, so it should not be sold. How did Dong arrive at that final number, and what do you think of her analysis? Should Instant sell the stock?

16-23 Joint cost allocation: sell immediately or process further. Iowa Soy Products (ISP) buys soy beans and processes them into other soy products. Each ton of soy beans that ISP purchases for $300 can be converted for an additional $200 into 500 pounds of soy meal and 100 gallons of soy oil. A pound of soy meal can be sold at splitoff for $1 and soy oil can be sold in bulk for $4 per gallon.

ISP can process the 500 pounds of soy meal into 600 pounds of soy cookies at an additional cost of $300. Each pound of soy cookies can be sold for $2 per pound. The 100 gallons of soy oil can be packaged at a cost of $200 and made into 400 quarts of Soyola. Each quart of Soyola can be sold for $1.25.

Required

1. Allocate the joint cost to the cookies and the Soyola using the following:
   a. Sales value at splitoff method
   b. NRV method
2. Should ISP have processed each of the products further? What effect does the allocation method have on this decision?

16-24 Accounting for a main product and a byproduct. (Cheatham and Green, adapted) Tasty, Inc., is a producer of potato chips. A single production process at Tasty, Inc., yields potato chips as the main product and a byproduct that can also be sold as a snack. Both products are fully processed by the splitoff point, and there are no separable costs.

For September 2012, the cost of operations is $500,000. Production and sales data are as follows:

	Production (in pounds)	Sales (in pounds)	Selling Price per Pound
Main Product:			
Potato Chips	52,000	42,640	$16
Byproduct	8,500	6,500	$10

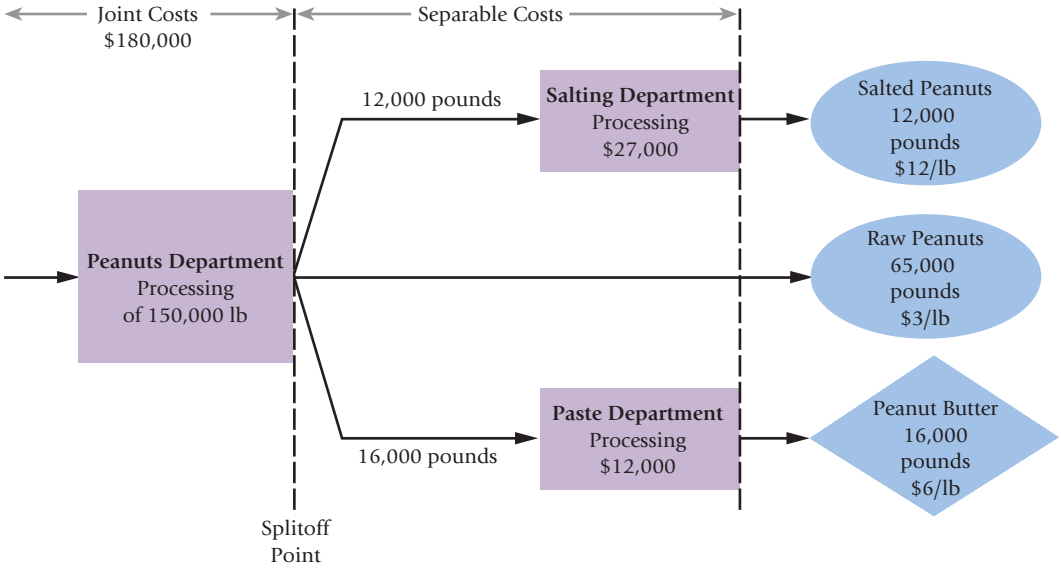
There were no beginning inventories on September 1, 2012.

1. What is the gross margin for Tasty, Inc., under the production method and the sales method of byproduct accounting?
2. What are the inventory costs reported in the balance sheet on September 30, 2012, for the main product and byproduct under the two methods of byproduct accounting in requirement 1?

16-25 Joint costs and byproducts. (W. Crum adapted) Royston, Inc., is a large food processing company. It processes 150,000 pounds of peanuts in the peanuts department at a cost of $180,000 to yield 12,000 pounds of product A, 65,000 pounds of product B, and 16,000 pounds of product C.

- Product A is processed further in the salting department to yield 12,000 pounds of salted peanuts at a cost of $27,000 and sold for $12 per pound.
- Product B (raw peanuts) is sold without further processing at $3 per pound.
- Product C is considered a byproduct and is processed further in the paste department to yield 16,000 pounds of peanut butter at a cost of $12,000 and sold for $6 per pound.

The company wants to make a gross margin of 10% of revenues on product C and needs to allow 20% of revenues for marketing costs on product C. An overview of operations follows:



Required

1. Compute unit costs per pound for products A, B, and C, treating C as a byproduct. Use the NRV method for allocating joint costs. Deduct the NRV of the byproduct produced from the joint cost of products A and B.
2. Compute unit costs per pound for products A, B, and C, treating all three as joint products and allocating joint costs by the NRV method.

Problems

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16-26 Accounting for a byproduct. Sunny Day Juice Company produces oranges from various organic growers in Florida. The juice is extracted from the oranges and the pulp and peel remain. Sunny Day considers the pulp and peel byproducts of its juice production and can sell them to a local farmer for $2.00 per pound. During the most recent month, Sunny Day purchased 4,000 pounds of oranges and produced 1,500 gallons of juice and 900 pounds of pulp and peel at a joint cost of $7,200. The selling price for a half-gallon of orange juice is $2.50. Sunny Day sold 2,800 half-gallons of juice and 860 pounds of pulp and peel during the most recent month. The company had no beginning inventories.

Required

1. Assuming Sunny Day accounts for the byproduct using the production method, what is the inventoriable cost for each product and Sunny Day's gross margin?
2. Assuming Sunny Day accounts for the byproduct using the sales method, what is the inventoriable cost for each product and Sunny Day's gross margin?
3. Discuss the difference between the two methods of accounting for byproducts.

16-27 Alternative methods of joint-cost allocation, product-mix decisions. The Southern Oil Company buys crude vegetable oil. Refining this oil results in four products at the splitoff point: A, B, C, and D. Product C is fully processed by the splitoff point. Products A, B, and D can individually be further refined into Super A, Super B, and Super D. In the most recent month (December), the output at the splitoff point was as follows:

- Product A, 322,400 gallons
- Product B, 119,600 gallons
- Product C, 52,000 gallons
- Product D, 26,000 gallons

The joint costs of purchasing and processing the crude vegetable oil were $96,000. Southern had no beginning or ending inventories. Sales of product C in December were $24,000. Products A, B, and D were further refined and then sold. Data related to December are as follows:

	Separable Processing Costs to Make Super Products	Revenues
Super A	$249,600	$300,000
Super B	102,400	160,000
Super D	152,000	160,000

Southern had the option of selling products A, B, and D at the splitoff point. This alternative would have yielded the following revenues for the December production:

- Product A, $84,000
- Product B, $72,000
- Product D, $60,000

Required

1. Compute the gross-margin percentage for each product sold in December, using the following methods for allocating the $96,000 joint costs:
   a. Sales value at splitoff
   b. Physical-measure
   c. NRV
2. Could Southern have increased its December operating income by making different decisions about the further processing of products A, B, or D? Show the effect on operating income of any changes you recommend.

16-28 Comparison of alternative joint-cost-allocation methods, further-processing decision, chocolate products. The Chocolate Factory manufactures and distributes chocolate products. It purchases cocoa beans and processes them into two intermediate products: chocolate-powder liquor base and milk-chocolate liquor base. These two intermediate products become separately identifiable at a single splitoff point. Every 1,500 pounds of cocoa beans yields 60 gallons of chocolate-powder liquor base and 90 gallons of milk-chocolate liquor base.

The chocolate-powder liquor base is further processed into chocolate powder. Every 60 gallons of chocolate-powder liquor base yield 600 pounds of chocolate powder. The milk-chocolate liquor base is further processed into milk chocolate. Every 90 gallons of milk-chocolate liquor base yield 1,020 pounds of milk chocolate.

Production and sales data for August 2012 are as follows (assume no beginning inventory):

- Cocoa beans processed, 15,000 pounds
- Costs of processing cocoa beans to splitoff point (including purchase of beans), $30,000

	Production	Sales	Selling Price	Separable Processing Costs
Chocolate powder	6,000 pounds	6,000 pounds	$4 per pound	$12,750
Milk chocolate	10,200 pounds	10,200 pounds	$5 per pound	$26,250

Chocolate Factory fully processes both of its intermediate products into chocolate powder or milk chocolate. There is an active market for these intermediate products. In August 2012, Chocolate Factory could have sold the chocolate-powder liquor base for $21 a gallon and the milk-chocolate liquor base for $26 a gallon.

Required

1. Calculate how the joint costs of $30,000 would be allocated between chocolate powder and milk chocolate under the following methods:
   a. Sales value at splitoff
   b. Physical-measure (gallons)
   c. NRV
   d. Constant gross-margin percentage NRV
2. What are the gross-margin percentages of chocolate powder and milk chocolate under each of the methods in requirement 1?
3. Could Chocolate Factory have increased its operating income by a change in its decision to fully process both of its intermediate products? Show your computations.

16-29 Joint-cost allocation, process further or sell. (CMA, adapted) Sonimad Sawmill, Inc., (SSI) purchases logs from independent timber contractors and processes the logs into three types of lumber products:

- Studs for residential buildings (walls, ceilings)
- Decorative pieces (fireplace mantels, beams for cathedral ceilings)
- Posts used as support braces (mine support braces, braces for exterior fences on ranch properties)

These products are the result of a joint sawmill process that involves removal of bark from the logs, cutting the logs into a workable size (ranging from 8 to 16 feet in length), and then cutting the individual products from the logs.

The joint process results in the following costs of products for a typical month:

Direct materials (rough timber logs)	$ 500,000
Debarking (labor and overhead)	50,000
Sizing (labor and overhead)	200,000
Product cutting (labor and overhead)	250,000
Total joint costs	$1,000,000

Product yields and average sales values on a per-unit basis from the joint process are as follows:

Product	Monthly Output of Materials at Splitoff Point	Fully Processed Selling Price
Studs	75,000 units	$ 8
Decorative pieces	5,000 units	100
Posts	20,000 units	20

The studs are sold as rough-cut lumber after emerging from the sawmill operation without further processing by SSI. Also, the posts require no further processing beyond the splitoff point. The decorative pieces must be planed and further sized after emerging from the sawmill. This additional processing costs $100,000 per month and normally results in a loss of 10% of the units entering the process. Without this planing and sizing process, there is still an active intermediate market for the unfinished decorative pieces in which the selling price averages $60 per unit.

Required

1. Based on the information given for Sonimad Sawmill, allocate the joint processing costs of $1,000,000 to the three products using:
   a. Sales value at splitoff method
   b. Physical-measure method (volume in units)
   c. NRV method
2. Prepare an analysis for Sonimad Sawmill that compares processing the decorative pieces further, as it currently does, with selling them as a rough-cut product immediately at splitoff.

3. Assume Sonimad Sawmill announced that in six months it will sell the unfinished decorative pieces at splitoff due to increasing competitive pressure. Identify at least three types of likely behavior that will be demonstrated by the skilled labor in the planing-and-sizing process as a result of this announcement. Include in your discussion how this behavior could be influenced by management.

16-30 Joint-cost allocation. Elsie Dairy Products Corp. buys one input, full-cream milk, and refines it in a churning process. From each gallon of milk Elsie produces three cups of butter and nine cups of buttermilk. During May 2010, Elsie bought 12,000 gallons of milk for $22,250. Elsie spent another $9,430 on the churning process to separate the milk into butter and buttermilk. Butter could be sold immediately for $2.20 per pound and buttermilk could be sold immediately for $1.20 per quart (note: two cups = one pound; four cups = one quart).

Elsie chooses to process the butter further into spreadable butter by mixing it with canola oil, incurring an additional cost of $1.60 per pound. This process results in two tubs of spreadable butter for each pound of butter processed. Each tub of spreadable butter sells for $2.30.

Required

1. Allocate the $31,680 joint cost to the spreadable butter and the buttermilk using the following:
   a. Physical-measure method (using cups) of joint cost allocation
   b. Sales value at splitoff method of joint cost allocation
   c. NRV method of joint cost allocation
   d. Constant gross margin percentage NRV method of joint cost allocation
2. Each of these measures has advantages and disadvantages; what are they?
3. Some claim that the sales value at split off method is the best method to use. Discuss the logic behind this claim.

16-31 Further processing decision (continuation of 16-30). Elsie has decided that buttermilk may sell better if it was marketed for baking and sold in pints. This would involve additional packaging at an incremental cost of $0.35 per pint. Each pint could be sold for $0.75 (note: one quart = two pints).

1. If Elsie uses the sales value at splitoff method, what combination of products should Elsie sell to maximize profits?
2. If Elsie uses the physical-measure method, what combination of products should Elsie sell to maximize profits?
3. Explain the effect that the different cost allocation methods have on the decision to sell the products at split off or to process them further.

16-32 Joint-cost allocation with a byproduct. Mat Place purchases old tires and recycles them to produce rubber floor mats and car mats. The company washes, shreds, and molds the recycled tires into sheets. The floor and car mats are cut from these sheets. A small amount of rubber shred remains after the mats are cut. The rubber shreds can be sold to use as cover for paths and playgrounds. The company can produce 25 floor mats, 75 car mats, and 40 pounds of rubber shreds from 100 old tires.

In May, Mat Place, which had no beginning inventory, processed 125,000 tires and had joint production costs of $600,000. Mat Place sold 25,000 floor mats, 85,000 car mats, and 43,000 pounds of rubber shreds. The company sells each floor mat for $12 and each car mat for $6. The company treats the rubber shreds as a byproduct that can be sold for $0.70 per pound.

Required

1. Assume that Mat Place allocates the joint costs to floor mats and car mats using the sales value at splitoff method and accounts for the byproduct using the production method. What is the ending inventory cost for each product and gross margin for Mat Place?
2. Assume that Mat Place allocates the joint costs to floor mats and car mats using the sales value at splitoff method and accounts for the byproduct using the sales method. What is the ending inventory cost for each product and gross margin for Mat Place?
3. Discuss the difference between the two methods of accounting for byproducts, focusing on what conditions are necessary to use each method.

16-33 Byproduct-costing journal entries (continuation of 16-32). The Mat Place's accountant needs to record the information about the joint and byproducts in the general journal, but is not sure what the entries should be. The company has hired you as a consultant to help its accountant.

Required

1. Show journal entries at the time of production and at the time of sale assuming the Mat Place accounts for the byproduct using the production method.
2. Show journal entries at the time of production and at the time of sale assuming the Mat Place accounts for the byproduct using the sales method.

16-34 Process further or sell, byproduct. (CMA, adapted) Rochester Mining Company (RMC) mines coal, puts it through a one-step crushing process, and loads the bulk raw coal onto river barges for shipment to customers.

RMC's management is currently evaluating the possibility of further processing the raw coal by sizing and cleaning it and selling it to an expanded set of customers at higher prices. The option of building a new

sizing and cleaning plant is ruled out as being financially infeasible. Instead, Amy Kimbell, a mining engineer, is asked to explore outside-contracting arrangements for the cleaning and sizing process. Kimbell puts together the following summary:

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	A	B	C
1	Selling price of raw coal	$ 27	per ton
2	Cost of producing raw coal	$ 21	per ton
3	Selling price of sized and cleaned coal	$ 35	per ton
4	Annual raw coal output	9,800,000	tons
5	Percentage of material weight loss in sizing/cleaning coal	10%	
6			
7		**Incremental Costs of Sizing & Cleaning Processes**	
8	Direct labor	$ 820,000	per year
9	Supervisory personnel	$ 225,000	per year
10	Heavy equipment: rental, operating, maintenance costs	$ 15,000	per month
11	Contract sizing and cleaning	$ 3.60	per ton of raw coal
12	Outbound rail freight	$ 210	per 60-ton rail car
13			
14	Percentage of sizing/cleaning waste that can be salvaged for coal fines	75%	
15	Range of costs per ton for preparing coal fine for sale	$2	$4
16	Range of coal fine selling prices (per ton)	$16	$27

Kimbell also learns that 75% of the material loss that occurs in the cleaning and sizing process can be salvaged as coal fines, which can be sold to steel manufacturers for their furnaces. The sale of coal fines is erratic and RMC may need to stockpile it in a protected area for up to one year. The selling price of coal fine ranges from $16 to $27 per ton and costs of preparing coal fines for sale range from $2 to $4 per ton.

Required

1. Prepare an analysis to show whether it is more profitable for RMC to continue selling raw bulk coal or to process it further through sizing and cleaning. (Ignore coal fines in your analysis.)
2. How would your analysis be affected if the cost of producing raw coal could be held down to $17 per ton?
3. Now consider the potential value of the coal fines and prepare an addendum that shows how their value affects the results of your analysis prepared in requirement 1.

16-35 Joint Cost Allocation. Memory Manufacturing Company (MMC) produces memory modules in a two-step process: chip fabrication and module assembly.

In chip fabrication, each batch of raw silicon wafers yields 400 *standard* chips and 600 *deluxe* chips. Chips are classified as standard or deluxe on the basis of their density (the number of memory bits on each chip). Standard chips have 500 memory bits per chip, and deluxe chips have 1,000 memory bits per chip. Joint costs to process each batch are $28,900.

In module assembly, each batch of standard chips is converted into standard memory modules at a separately identified cost of $1,050 and then sold for $14,000. Each batch of deluxe chips is converted into deluxe memory modules at a separately identified cost of $2,450 and then sold for $26,500.

Required

1. Allocate joint costs of each batch to deluxe modules and standard modules using (a) the NRV method, (b) the constant gross-margin percentage NRV method, and (c) the physical-measure method, based on the number of memory bits. Which method should MMC use?
2. MMC can process each batch of 400 standard memory modules to yield 350 DRAM modules at an additional cost of $1,600. The selling price per DRAM module would be $46. Assume MMC uses the physical-measure method. Should MMC sell the standard memory modules or the DRAM modules?

16-36 Joint cost allocation, ending work in process inventories. Tastee Freez, Inc., produces two specialty ice cream mix flavors for soft serve ice cream machines. The two flavors, Extreme Chocolate and Very Strawberry, both start with a vanilla base. The vanilla base can be sold for $2 per gallon. The company did not have any beginning inventories but produced 8,000 gallons of the vanilla base during the most recent month at a cost of $5,200. The 8,000 gallons of base was used to begin production of 5,000 gallons of Extreme Chocolate and 3,000 gallons of Very Strawberry.

At the end of the month, the company had some of its ice cream mix still in process. There were 1,200 gallons of Extreme Chocolate 30% complete and 200 gallons of Very Strawberry 80% complete. Processing costs during the month for Extreme Chocolate and Very Strawberry were $9,152 and $8,880, respectively. The selling prices for Extreme Chocolate and Very Strawberry are $4 and $5, respectively.

Required

1. Allocate the joint costs to Extreme Chocolate and Very Strawberry under the following methods:
   a. Sales value at splitoff
   b. Net realizable value
   c. Constant gross margin percentage NRV
2. Compute the gross margin percentages for Extreme Chocolate and Very Strawberry under each of the methods in requirement 1.

Collaborative Learning Problem

16-37 Joint Cost Allocation, processing further and ethics. Unified Chemical Company has a joint production process that converts Zeta into two chemicals: Alpha and Beta. The company purchases Zeta for $12 per pound and incurs a cost of $30 per pound to process it into Alpha and Beta. For every 10 pounds of Zeta, the company can produce 8 pounds of Alpha and 2 pounds of Beta. The selling price for Alpha and Beta are $76.50 and $144.00, respectively.

Unified Chemical generally processes Alpha and Beta further in separable processes to produce more refined products. Alpha is processed separately into Alphalite at a cost of $25.05 per pound. Beta is processed separately into Betalite at a cost of $112.80 per pound. Alphalite and Betalite sell for $105 and $285 per pound, respectively. In the most recent month, Unified Chemical purchased 15,000 pounds of Zeta. The company had no beginning or ending inventory of Zeta.

Required

1. Allocate the joint costs to Alphalite and Betalite under the following methods:
   a. Sales value at splitoff
   b. Physical measure (pounds)
   c. Net realizable value
   d. Constant gross margin percentage NRV
2. Unified Chemical is considering an opportunity to process Betalite further into a new product called Ultra-Betalite. The separable processing will cost $85 per pound and expects an additional $15 per pound packaging cost for Ultra-Betalite. The expected selling price would be $360 per pound. Should Unified Chemical sell Betalite or Ultra-Betalite? What selling price for Ultra-Betalite would make Unified Chemical indifferent between selling Betalite and Ultra-Betalite?
3. Independent of your answer to requirement (2), suppose Danny Dugard, the assistant controller, has completed an analysis that shows Ultra-Betalite should not be produced. Before presenting his results to top management, he received a visit from Sally Kemper. Sally had been personally responsible for developing Ultra-Betalite and was upset to learn that it would not be manufactured.

   Sally: The company is making a big mistake by passing up this opportunity. Ultra-Betalite will be a big seller and will get us into new markets.
   Danny: But the analysis shows that we would be losing money on every pound of Ultra-Betalite we manufacture.
   Sally: But that is a temporary problem. Eventually the cost of processing will be reduced.
   Danny: Do you have any estimates on the cost reductions you expect?
   Sally: There is no way of knowing that right now. Can't you just fudge the numbers a little to help me get approval to produce Ultra-Betalite. I am confident that cost reductions will follow.

   Comment on the ethical issues in this scenario. What should Danny do?