CHAPTER 8 COST ALLOCATION: JOINT PRODUCTS AND BYPRODUCTS

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 8 – 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.

Exhibit 8 – 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

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. Some outputs of

a joint production process have “negative” revenue when their disposal costs (such as the costs of handling non salable 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. For 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.

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 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.
- 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.
- 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.

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. 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 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.

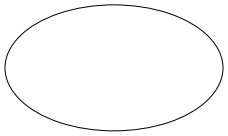
In the simplest joint production process, the joint products are sold at the splitoff point without further processing. Example 1 illustrates the two methods that apply in this case: the sales value at splitoff method and the physical-measure method. Then we introduce joint production processes that yield products that require further processing beyond the

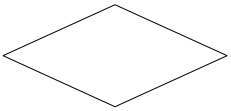
splitoff point. Example 2 illustrates the NRV method and the constant – gross margin percentage NRV method. To help you focus on key concepts, we use numbers and amounts that are smaller than the numbers that are typically found in practice.

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

Joint Product or Main Product

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:

	Joint Costs	
Joint costs (costs of 110,000 gallons raw milk and processing to splitoff point		$400,000
	Cream	**Liquid Skim**
Beginning inventory (gallons)	0	0
Production (gallons)	25,000	75,000
Sales (gallons)	20,000	30,000
Ending inventory (gallons)	5,000	45,000
Selling price per gallon	$ 8	$ 4

Exhibit 8 – 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.

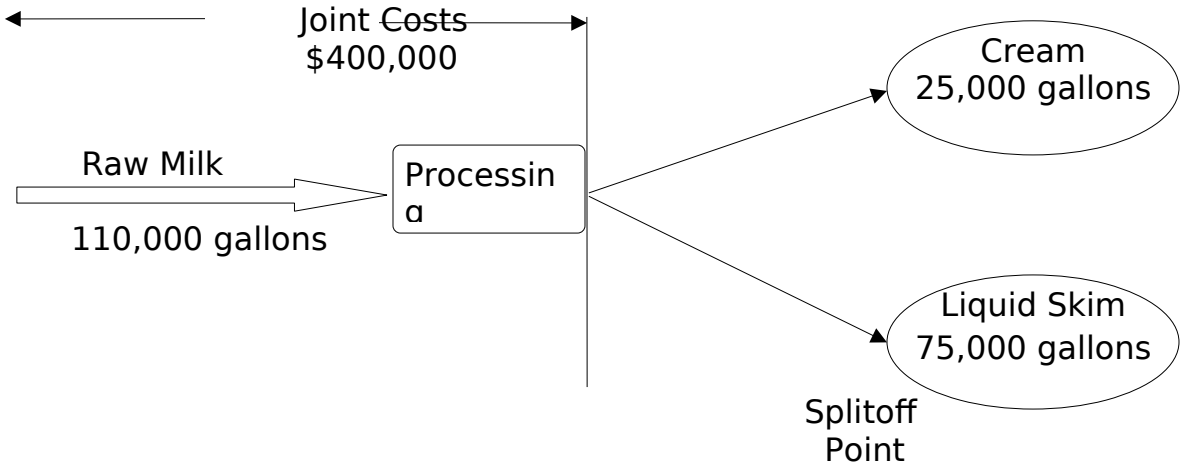
Sales Value at Splitoff Method

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 8 – 3, Panel A, shows how joint costs 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 8 – 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%.

Exhibit 8 – 2 Example 1: Overview of Farmers' Dairy



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 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.

Exhibit 8 – 3 Joint – Cost Allocation and Product – Line Income Statement Using Sales Value at Splitoff Method: Farmers' Dairy for May 2012

PANEL A: Allocation of Joint Costs Using Sales Value at Splitoff Method	**Cream**	**Liquid Skim**	**Total**
Sales value of total production at splitoff point			
(25,000 gallons × $8 per gallon; 75,000 gallons × $4 per gallon)	$200,000	$300,000	$500,000
Weighting ($200,000 ÷ $500,000; $300,000 ÷ 500,000)	0.40	0. 60	
Joint costs allocated (0.40 × $400,000; 0.60 × $400,000)	$160,000	$240,000	400,000
Joint production cost per gallon			

($160,000 ÷ 25,000 gallons; $240,000 ÷ 75,000 gallons)	$6.40	$3.20	
PANEL B: Product-Line Income Statement Using Sales Value at Splitoff Method for May 2012	**Cream**	**Liquid Skim**	**Total**
Revenues (20,000 gallons × $8 per gallon; 30,000 gallons × $4 per gallon)	$160,000	$120,000	$280,000
Cost of goods sold (joint costs)			
Production costs (0.40 × $400,000; 0.60 × $400,000)	160,000	240,000	400,000
Deduct ending inventory (5,000 gallons × $6.40 per gallon; 45,000 gallons × $3.20 per gallon)	32,000	144,000	176,000
Cost of goods sold (joint costs)	128,000	96,000	224,000
Gross margin	$32,000	$24,000	56,000
Gross margin percentage ($32,000 ÷ $160,000; $24,000 ÷ $120,000; $56,000 ÷ $280,000)	20%	20%	20%

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 8 – 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 8 – 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 (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.

Exhibit 8 – 4 Joint-Cost Allocation and Product-Line Income Statement Using Physical-Measure Method: Farmers' Dairy for May 2012

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

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 → Butter cream: 25,000 gallons of cream are further processed to yield 20,000 gallons of butter cream at additional processing costs of $280,000. Butter cream, 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 butter cream and 45,000 gallons of condensed milk.

Exhibit 8 – 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 butter cream and liquid skim is separately processed into condensed milk. Panel B shows the data for Example 2.

Exhibit 8 – 5 Example 2: Overview of Farmers' Dairy (*continued*)

PANEL B: Data for Example 2

	Joint Costs		**Butter cream**	**Condensed Milk**
Joint costs (costs of 110,000 gallons raw milk and processing to splitoff point)	$400,000			
Separable cost of processing 25,000 gallons cream into 20,000 gallons butter cream			$280,000	
Separable cost of processing 75,000 gallons liquid skim into 50,000 gallons condensed milk				$520,000
	Cream	**Liquid**	**Butter cream**	**Condensed Milk**

		Skim		
Beginning inventory (gallons)	0	0	0	0
Production (gallons)	25,000	75,000		
Transfer for further processing (gallons)	25,000	75,000	20,000	50,000
Sales (gallons)			12,000	45,000
Ending inventory (gallons)	0	0	8,000	5,000
Selling price per gallon	$8	$4	$25	$22

Exhibit 8 – 6 Joint – Cost Allocation and Product – Line Income Statement Using NRV Method: Farmers' Dairy for May 2012

PANEL A: Allocation of Joint Costs Using Net Realizable Value Method	**Butter cream**	**Condensed Milk**	**Total**
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
Deduct separable costs	280,000	520,000	800,000
Net realizable value at splitoff point	220,000	580,000	800,000
Weighting ($220,000 ÷ $800,000; $580,000 ÷ $800,000)	0.275	0.725	
Joint costs allocated (0.275 × $400,000; 0.725 × $400,000)	$110,000	$290,000	$400,000
Production cost per gallon			
([$110,000 + $280,000] ÷ 20,000 gallons; [$290,000 + $520,000] ÷ 50,000 gallons)	$19.50	$16.20	
PANEL B: Product-Line Income Statement Using Net Realizable Value Method for May 2012			
	Butter cream	**Condensed Milk**	**Total**
Revenues (12,000 gallons × $25 per gallon; 45,000 gallons × 22 per gallon)	$300,000	$990,000	$1,290,000
Cost of goods sold			
Joint costs (0.275 × $400,000; 0.725 × $400,000)	110,000	290,000	400,000
Separable costs	280,000	520,000	800,000
Production costs	390,000	810,000	1,200,000
Deduct ending inventory (8,000 gallons × $19.50 per gallon; 5,000 gallons × $16.20 per gallon)	156,000	81,000	237,000
Cost of goods sold	234,000	729,000	963,000
Gross margin			
Gross margin percentage ($66,000 ÷ $300,000; $261,000 ÷ $990,000; $327,000 ÷ $1,290,000)	22.0%	26.4%	25.3%

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 8 – 6, Panel A, shows how joint costs are allocated to individual products to calculate cost per gallon of butter cream and condensed milk.

Exhibit 8 – 6, Panel B presents the product – line income statement using the NRV method. Gross – margin percentages are 22.0% for butter cream 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 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 8 – 7, Panel A, shows these steps for allocating the $400,000 joint costs between butter cream and condensed milk in the Farmers' Dairy example.

As we describe each step, refer to Exhibit 8 – 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 8 – 7, Panel A, uses $1,600,000, the final expected sales value of the entire output of butter cream 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 8 – 7, Panel B, presents the product-line income statement for the constant gross margin percentage NRV method.

Exhibit 8 – 7 Joint – Cost Allocation and Product –Line Income Statement Using Constant Gross – Margin Percentage NRV Method: Farmers' Dairy for May 2012

PANEL A: Allocation of Joint Costs Using Constant Gross-Margin Percentage NRV Method			
Step 1			
Final sales value of total production during accounting period:			
(20,000 gallons × $25 per gallon) + (50,000 gallons × $22 per gallon)	$1,600,000		
Deduct joint and separable costs ($400,000 + $280,000 + $520,000)	1,200,000		
Gross margin	$400,000		
Gross margin percentage ($400,000 ÷ $1,600,000)	25%		
	Butter cream	**Condensed Milk**	**Total**
Step 2			
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
Deduct gross margin, using overall gross-margin percentage (25% × $500,000; 25% × $1,100,000)	125,000	275,000	400,000
Total production costs	375,000	825,000	$ 1,200,000
Step 3			
Deduct separable costs	280,000	520,000	800,000

Joint costs allocated	$95,000	$305,000	$400,000
PANEL B: Product-Line Income Statement Using Constant Gross-Margin Percentage NRV Method for May 2012			
	Butter cream	**Condensed Milk**	**Total**
Revenues (12,000 gallons × $25 per gallon; 45,000 gallons × $22 per gallon)	$300,000	$990,000	$1,290,000
Cost of goods sold			
Joint costs (from Panel A)	95,000	305,000	400,000
Separable costs	280,000	520,000	800,000
Production costs	375,000	825,000	1,200,000
Deduct ending inventory			
(8,000 gallons × $18.75 per gallon [a]; 5,000 gallons × $16.50 per gallon [b])	150,000	82,500	232,500
Cost of goods sold	225,000	724,500	967,500
Gross margin	$ 75,000	247,500	322,500
Gross margin percentage	25%	25%	25%
[a]Total production costs of butter cream ÷ Total production of butter cream = $375,000 ÷ 20,000 gallons = $18.75 per gallon. [b]Total production costs of condensed milk ÷ Total production of condensed milk = $825,000 ÷ 50,000 gallons = $16.50 per gallon.			

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

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.

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.

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.

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."

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.

Irrelevance of Joint Costs for Decision Making

Relevant revenues are 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.

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

Further Processing Cream into Butter cream	
Incremental revenues ($25/gallon * 20,000 gallons) - ($8/gallon * 25,000 gallons)	$300,0

	00
Deduct incremental processing costs	280,000
Increase in operating income from butter cream	$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 butter cream 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 butter cream; 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. Suppose *allocated* fixed corporate and administrative costs of further processing cream into butter cream equal $30,000 and that these costs will be allocated only to butter cream and to the manager's product-line income statement if butter cream 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 butter cream. However, producing the butter cream 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 butter cream 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 butter cream.

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 8 – 3) exceed the joint costs ($400,000) 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 8 – 4, 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

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! 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

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.

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.)

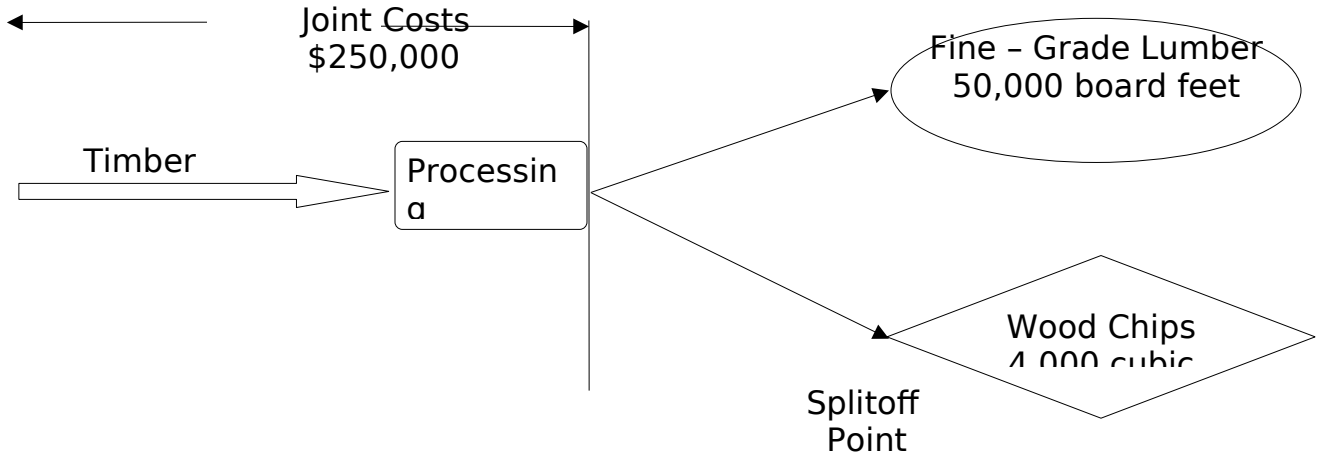
Data for July 2012 are as follows:

	Beginning Inventory	**Production**	**Sales**	**Ending Inventory**
Fine – Grade lumber	0	50,000	40,0	10,000

(b.f.)			00	
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 8 – 8 shows.

Exhibit 8 – 8 Example 3: Overview of Westlake Corporation



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. Exhibit 8 – 9 presents the income statement of Westlake Corporation under both methods.

Exhibit 8 – 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. x $6 per b.f.)	$240,000	$240,000
Byproduct: Wood chips (1,200 c.f. x $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. x $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. x $1 per c.f.)[c]	2,800	0
[a](10,000 ÷ 50,000) x net manufacturing cost = (10,000 ÷ 50,000) x $246,000 = $49,200. [b](10,000 ÷ 50,000) x total manufacturing cost = (10,000 ÷ 50,000) x $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) x $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%). 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 x $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)	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)	Finished Goods – Fine – Grade Lumber	250,000	
	Work in Process ($150,000 + $100,000)		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	Cash or Accounts Receivable (40,000 b.f. * $6 per b.f.)	240,0	

)		00	
	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.		

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.